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Learned Responses in Preterm Infants

by

Rose Marie Boyle

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the

requirements for the degree of Master of Nursing

Faculty of Nursing

Edmonton, Alberta

Fall 1995

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a theses entitled LEARNED RESPONSES IN PRETERM INFANTS submitted by Rose Marie Boyle in partial fulfillment of the requirements for the degree of Master of Nursing

Dr. Janice Lander
Supervisor

Dr. Keith Barrington
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Dr. Kathrine Peters
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Date: October 6, 1995

Abstract

The focus of this research was learned responses of premature infants to stimuli in the NICU environment. the thesis is divided into two papers. The first describes conditioning of a heart rate to a clicking tone when paired with suctioning. Subjects were three preterm infants, 24-29 weeks gestation. Physiologic data and video-recorded infant behaviour were obtained before, during and following suctioning. Conditioned responses were not demonstrated. One infant did not have an unconditioned response to suctioning (a precursor to successful conditioning). The importance of conditioned responses in health outcomes for infants are exposed. The main finding reported in this paper is that infants are exposed to a high frequency of noxious events. It is suggested that the environment be examined with a view to reducing infant distress.

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Thesis Overview

The thesis research described in this document relates to learned or conditioned responses in preterm infants. The purpose of this overview is to summarize and integrate my overall thesis project and the parts that comprise the thesis. This document is composed of three distinct sections; the overview, and two manuscripts. The first manuscript is an account of a research project entitled *Conditioned Responses To Sensory Stimulation: Preterm Infants*. The second manuscript entitled *Infant Responses to Environmental Stimuli*, describes infant responses to environmental stimuli and routine events in the Neonatal Intensive Care Unit (NICU).

Background

Premature infants in the NICU may be affected by a variety of stimuli. Clinical observations suggested preterm infants have the potential to develop conditioned responses to various stimuli in the NICU environment. These responses were unplanned and therefore the cues or unconditioned stimuli associated with them were difficult to pinpoint. Abnormal or aberrant infant behaviour as a result of conditioned responses may be a source of difficulties for parents and staff, and may ultimately be responsible for an unstable clinical condition or prolonged hospitalization. As an example, an infant given a soother prior to a heelstick may come to associate sucking with distress and pain, leading to feeding difficulties.

A previous study in the same NICU setting suggested that premature

infants displayed conditioned responses associated with endotracheal suctioning[1]. In that study infant heart rate rose significantly *after* initial endotracheal suctioning procedure, as would be expected.. Subsequent suctioning procedures revealed a heart rate rise *prior to* the commencement of endotracheal suctioning. This led to the question of whether or not the infants were learning to associate environmental cues related to the preparatory events of the suctioning with the procedure itself and thus anticipating an unpleasant event. If this is the case, then premature infants are at risk to develop similar anticipatory responses with possible long-term sequelae for the many distressing procedures and noxious stimuli in the NICU.

Conditioned Responses

The first manuscript which can be found on pages 8-35 describes the results of a single subject study. Three preterm infants between 24 and 29 weeks gestation were studied. A neutral stimulus was presented to the infants prior to their first suctioning procedure (Phase I). Then the stimulus was paired with the infants first through fourth suctioning procedures (Phase II). Finally the tone was presented following the fourth suctioning to assess for the presence of a conditioned response (Phase III). Each phase was composed of one or more sessions (a single session for Phases I and III and four sessions for Phase II). A session consisted of at three trials: baseline, tone (or tone followed by suctioning), and follow-up. The design is presented in Figure 1.

Physiologic data collected were heart rate, respiratory rate, blood

pressure (systolic, diastolic, and mean), and oxygen saturation. All sessions of data collection included simultaneous video recording of the infant which included audio recording of the environment.

Briefly, the findings were:

- the lack of an unconditioned response to suctioning in one of the infants (this being a precursor to successful conditioning of the type attempted in this study); and
- the finding that environmental stimuli were a source of hear rate elevation in infants.

The manuscript contains many graphs illustrating changes in heart rate through various phases, sessions and trials. There were, however, many more graphs of heart rate data which were produced and many are included in Appendix A for future reference. Heart rate over time for all phases and infants is the primary information included.

Responses to Environmental Stimuli

As mentioned, the continuous data and video recordings revealed interesting infant responses to alarms and various noises in the NICU. We decided that the matter was worthy of further study and the results could be presented in a second manuscript entitled *Infant Responses to Environmental Stimuli*. The purpose of the second manuscript was to describe the type and occurrence of physiologic and behavioural responses of the infants.

Using the video tapes from the study, I examined each carefully,

documenting the events (and their frequency), infant responses, and time of occurrence. I matched the computer and video records so that I could compare events and responses.

The infants observed were exposed to a substantial amount of environmental stimuli. Furthermore, these infants experienced many potentially distressing events, such as re-positioning, temperature taking, and change of diaper. Noise was the most frequently occurring of the events. This included staff talking, alarms ringing, and equipment and garbage cans banging.

The results can be summarized as follows:

- infants are exposed to many noises and much handling (some of it unnecessary);
- infants responded with heart rate increases and movement to many of these events;
- staff were often oblivious to the response of the infant, indicating that they would not take necessary action; and
- it was concluded that the NICU environment should be carefully examined and adjustments made to reduce the unnecessary stimulation.

Other Materials

Several documents are included in the appendices. The individual heart rate graphs in Appendix A have already been mentioned. Appendix B contains a copy of a consent form and the ethics approval form.

Conclusion

The thesis research process and findings were very useful to me. As a clinician, the process made me aware of the importance of clinical research and the use of the single subject design in answering clinical questions. It also made me aware of a different set of demands that clinical researchers face compared to clinicians, such as the need for precision with the protocol versus the organization of care and demands of routine clinical practice. As a graduate student, the process was a useful step in research and it drew together the theoretical concepts I had learned in my studies.

As a graduate student researcher, the findings have given me the incentive to continue research in this area. I am convinced that this area of research is an important one. As a clinician with considerable experience in NICU, I was astonished at the frequency of noxious events to which infants continue to be exposed. Moreover, the videotapes presented me with objective evidence that some staff do not detect infant responses and therefore are unable to meet individual infant needs. The findings will therefore be useful for me in educating staff and in making recommendations for patient care assignments.

Finally, I plan to submit both papers for publication and will be presenting the findings to various groups. I look forward to continuing my involvement in perinatal research.

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Figure 1: Phases, Sessions and Trials of the Study

PHASE I			PHASE II												PHASE III		
Baseline			Suctioning												Conditioned Response		
Session 1			Session 1			Session 2			Session 3			Session 4			Session 1		
Trials			Trials			Trials			Trials			Trials			Trials		
1	2	3	1	2	3	1	2	3	1	2	3		2	3	1	2	3

Phase I - Session 1: Baseline assessment
Phase II - Sessions 1-4: Four suctioning episodes
Phase III - Sessions 1-3: Three tests of conditioned response

Trial 1 - Baseline
Trial 2 - Tone (or tone followed by suctioning in the case of Phase II)
Trial 3 - Recovery

CONDITIONED RESPONSES TO SENSORY STIMULATION:

PRETERM INFANTS

Abstract

Premature infants may be exposed to a variety of sensory stimulation during their stay in NICU (Neonatal Intensive Care Unit) . Both clinical observations and findings from previous research suggest that infants may develop troublesome conditioned responses to various stimuli.

A single subject experimental study was conducted to assess the occurrence of conditioned responses from endotracheal suctioning. Premature infants were provided with a novel but neutral stimulus immediately prior to endotracheal suctioning. The stimulus was a clicking tone. Observations of three preterm infants between 24 and 29 weeks gestation were made during three phases: baseline, pairing of tone with suctioning, and test of conditioning. Each phase consisted of one or more sessions. Sessions consisted of three trials: baseline, tone (or tone followed by suctioning), and conditioned response assessment. Physiologic data (heart rate, blood pressure, respiratory rate, and oxygen saturation) and simultaneous video recording were obtained during each phase and session-trial.

Failure to demonstrate a conditioned response in the infants was attributed to technical problems and individual variations in infants. Infants were observed to respond to environmental noise, leading to the suggestion that further research be conducted on the effect of noise in the NICU. Further research is also indicated to investigate whether or not conditioned responses can be elicited from preterm infants.

CONDITIONED RESPONSES TO SENSORY STIMULATION: PRETERM INFANTS

Preterm infants may be affected by a variety of stimuli in the NICU. Our clinical observations suggest that infants may develop learned (that is, conditioned) responses to various stimuli. These conditioned responses are unplanned and therefore the stimulus cues (or unconditioned stimuli) are difficult to pinpoint. Moreover, conditioned responses made by infants may be a source of difficulties for staff and parents and may, ultimately, be the reason for an unstable condition or for prolonged hospitalization. For example, infants experiencing only negative oral stimulation associated with suctioning and tube insertions may come to associate oral stimulation with discomfort and distress, leading to feeding difficulties. The type of learned responses we were interested in examining were much more subtle than this. We were interested in examining learned responses to stimuli that could be embedded in a complex background of events, including distressing procedures and environmental turmoil.

Suctioning is recognized as a distressing procedure. A previous study in our NICU examined suctioning practices for preterm infants. In that study, infant heart rate rose significantly during the first suctioning event. By the second or third suctioning, infant heart rate rose significantly *before* suctioning [1]. This raised the question of whether infants were associating some subtle environmental cues with the unpleasant experience of suctioning. Although premature infants have been observed to respond unfavourably to distressing procedures, the specific cues which signal the

infant about the impending occurrence of a distressing procedure have not been pinpointed. The purpose of the study was to determine if learned responses occur in premature infants receiving routine endotracheal suctioning.

REVIEW OF THE LITERATURE:

It is well known that certain (unconditioned) stimuli evoke reflex responses (for example, salivation in Pavlov's dogs). These unconditioned responses are viewed as involuntary and beyond the control of the individual. The startle response of the newborn to a loud noise is an unconditioned response as described in classical conditioning theory in the psychology literature. The connection between the unconditioned stimulus and the unconditioned response is viewed as being automatic and not a learned response.

Classical conditioning can be employed to elicit a response from a neutral stimulus (like a bell), by pairing it with an unconditioned stimulus (like food), to produce a reflex response or unconditioned response (like salivation). After pairing the neutral stimulus with the unconditioned stimulus, the neutral stimulus alone will eventually elicit the response. When this is achieved the neutral stimulus becomes known as the conditioned stimulus and the response as the conditioned response [2].

There are striking similarities in the literatures devoted to classical conditioning and pain. The much-disputed view that infants are unable to experience pain, due to cortical immaturity appears in the nursing and medical literature and have only recently been refuted [3]. In the psychology literature, newborn infants have been viewed as being incapable of conditioning due to cortical immaturity and despite

evidence to the contrary [4].

Lipsett [4] has presented evidence that demonstrates the ability of newborn infants to condition. In a study using eye blink responses to a puff of air, the interval between the conditioned and unconditioned stimulus was examined. Conditioning occurred at an interval of between 1.5 and 2 seconds. Blass [5] demonstrated anticipation of sucrose in response an auditory stimulus. A click sound elicited conditioned responses, while other auditory stimuli failed to do so.

It has been suggested that preterm infants' reactions to stimulation affect the quality of his or her interactions with the social and physical world and that the differences in full term infants' abilities to react compared with preterm infants might be the basis of different patterns of social interactions in infancy and childhood [6].

Infants are subjected to medical and nursing procedures with largely unknown behavioural and physiologic outcomes [7]. Paradoxically, the most immature or critically ill infant requires the greatest number of interventions and receives the largest amount of handling in the NICU and yet is least able to handle the associated stress [7,8,9].

Repeated exposure to excessive handling and distressing procedures can cause hypoxemia, and have long term consequences for the developing brain of the premature infant [1,10,11]. The cerebral vascular bed in premature infants is especially vulnerable to insults due to its limited capacity for autoregulation. Hypoxemia in particular can result in a loss of autoregulation and has the potential to lead to intra ventricular haemorrhage. Numerous environmental stimuli impinge upon the sensory

systems of preterm infants in NICU. The potential for central nervous system dysfunction as a result of negative and distorted sensory input in critically ill infants is great [10].

When preterm infants' behavioural and cardiac responses to repeated auditory stimuli were examined, preterms were unable to habituate to repeated presentations of stimuli [12]. This means that these infants were unable to ignore redundant input from the environment and were at the mercy of external stimulus events. Failure to habituate is manifested in difficulty attending to diverse stimuli and being highly reactive once the stimulus captures attention. In addition, when the preterm infant responds to a stimulus, his/her immature homeostatic mechanisms are readily overwhelmed by unsuitable or excessive stimulation [12]. Recently, the effect of NICU noise on habituation was examined using newborn chicks [13]. Four day old chicks reared with NICU noise failed to habituate, and the atypical sound exposure altered behavioural organization. Noise in the NICU may also influence preterm infants' abilities to habituate. If preterm infants are failing to habituate to sounds in their environment, then perhaps they become over-responsive to auditory stimulation in the NICU. Preterm infants may similarly respond to handling and distressing procedures.

Endotracheal suctioning is an essential but potentially distressing procedure [14] which is often carried out in the NICU setting. Infants receiving assisted ventilation require suctioning to prevent occlusion of the endotracheal tube [10]. It is also done routinely in many NICU settings prior to gavage feedings. The pattern of recurrence and the effects on infant state that are associated with suctioning, signal the potential

development of conditioned responses.

As previously mentioned, infant distress may occur *prior to* endotracheal suctioning, as though the infant anticipated what was to come. This raises the question of whether or not infants are associating some subtle environmental cues with the unpleasant experience of suctioning. The topic of this research was the occurrence of learned responses in premature infants receiving routine endotracheal suctioning. If learned responses do occur, then it should be possible to demonstrate by pairing a neutral stimulus with suctioning and subsequently testing the effect of the neutral stimulus alone. Demonstration of a conditioned response in the NICU would provide the initial step in explaining (and later managing) some problematic aspects of infant behaviour.

METHOD:

Setting:

Neonates were studied in a tertiary level NICU. The NICU had a bed capacity of 30 to provide intensive care for infants requiring mechanical ventilation. The number of admissions per year averaged 600, of which approximately 55% were born in the hospital. The remaining 45% were transported from a large referral area.

Practice in the NICU at the time of this study was to use a humidity tent over the radiant warming bed for extremely low birth weight infants, to minimize insensible water losses. Infants were suctioned on a 4 to 6 hourly basis as determined by the nurse caring for the infant, and occasionally frequencies were modified by the attending physician as determined by any changes in clinical condition.

Sample:

Three neonates between 24 and 29 weeks gestation were studied on the first day of life, following admission to the NICU. All infants had been born in the hospital. Criteria for entry into the study included the following:

- being between 24 and 29 weeks gestation (these infants were likely to have the longest length of stay and most procedures in the NICU and consequently be at risk for development of conditioned responses);
- not having had cardiopulmonary resuscitation (CPR), birth asphyxia or cord pH of < 7.05, or abnormal neurological exam (to minimize the number of infants incapable of responding to stimuli due to neurological impairment);
- intubated, but not yet having received endotracheal suctioning;
- having an indwelling arterial line (for invasive blood pressure monitoring);
- having no previous continuous infusion of sedatives or analgesics;
- not having chromosomal abnormalities;
- having stable ventilatory parameters;
- not having high inotrope requirements (dopamine infusion at > 10 mcg/kg/min or epinephrine > 0.1 mcg/kg/min).

The sample size of three provided three single-subject studies. Subject A was a female born by cesarean section for maternal pulmonary edema and toxaemia at 29 weeks gestation. The infant received surfactant and required dopamine to manage hypotension. Subject B was a female born at 27 weeks gestation following an induction for maternal chorioamnionitis. She was delivered vaginally, received

dopamine for hypotension, and surfactant. This infant also received one dose of midazolam [15] for sedation between phases II and III. Subject C was a male born at 25 weeks gestation by spontaneous vaginal delivery. He required blood volume expanders and dopamine to manage hypotension but did not receive surfactant.

Equipment:

Heart rate, blood pressure, and pulse oximetry were collected by a Hewlett Packard Merlin continuously monitored at the rate of one reading per second. Blood pressure (systolic, diastolic, and mean) was obtained from an umbilical arterial catheter and a disposable transducer (neonatal custom kit). Oxygen saturation was monitored with a Nellcor probe which was protected from ambient lighting. The physiologic data was collected by the Merlin and immediately transferred to a computer for storage. The computer was programmed to record data on a one sample per second basis in column format and to insert an event marker in the data on request.

A professional colour video camera and monitor were used to display and record all data collection sessions. The camera was focused on the infant. An event marker was connected to the video to generate a high frequency tone which was recorded on the videotape but was not audible in the NICU when made. This permitted marking of events on the videotape to facilitate synchronization of video and computer events.

Sound levels in the NICU were measured with a Simpson 286 sound meter at varying times of the day and night before initiation of the study. The volume of the

neutral auditory stimulus that was needed to ensure it would be audible over NICU background noise was determined. This was done by assessing various volumes coming from speakers (attached to a cassette player), placed on an unoccupied radiant warmer bed in the NICU and comparing them to the NICU noise level.

The neutral stimulus chosen was a repetitive clicking sound (like a metronome click). As previously noted, this tone has been demonstrated to be effective with term infants in conditioning trials [5].

Procedure:

Infants from whom informed parental consents were obtained were enrolled in the study. The data collection equipment was set up at the bedside next to the radiant warmer bed at least one hour prior to the infants' first endotracheal suctioning procedure. Two small speakers were placed at the end of the bed and 10 cm to each side of the infant's head. The speakers were connected to a cassette recorder.

The camera was secured on a camera mount attached to the end of a pole and suspended over the infant. It was focused so that the whole infant could be photographed. Video recording the infant during the data collection period provided an objective recording of events which could be played and re-played during analysis.

The infant's blood pressure transducer, EKG leads, and pulse oximeter probe were disconnected from the bedside monitor and connected to the Merlin monitor. The blood pressure transducer was recalibrated. The quality of the EKG tracing and the blood pressure display were visually inspected and adjustments made if necessary to produce an optimal recording. The equipment remained in place until the end of

the last phase of data collection, although video recording and collection of physiologic data continued only during the phases of data collection.

Data collection was partitioned into three phases: baseline, stimulus pairing, and conditioned response. Each phase consisted of one or more sessions with trials embedded in sessions. Figure 1 illustrates the organization of the study. The amount of time required for sessions and trials varied over the study for any subject and also varied from subject to subject. The variability in duration of phases (or sessions and trials) occurred as the result of variable lengths of time required to suction an infant and availability of staff to do the suctioning.

Phase I: Baseline The Baseline Phase consisted of one session with three trials. At least 30 minutes before the infant's first endotracheal suctioning, the video recording and storage of physiologic data commenced. Trial 1 consisted of a 5-minute baseline, obtained when the infant was stable and settled. Trial 2, occurring immediately after trial 1, consisted of the playing of the audio recorded tone. This was done to record the infant's initial reaction to the tone. Computer and video markers were generated at the sound of the tone to mark the occurrence of the event. Trial 3 consisted of another five minutes of post-tone recording. A 30-minute break occurred during which recording ceased and the infant was disturbed only for essential care.

Phase II: Stimulus Pairing This phase consisted of four sessions of endotracheal suctioning: the infant's first and next three suctioning procedures, occurring four to six hours apart. The first suctioning session consisted of four trials:

5-minute baseline, delivery of the neutral tone, suctioning, and, lastly, a 10-minute return to baseline trial. Infants were suctioned using the standard two person NICU procedure. At the end of the session, computer data collection and the video recording ended but clinical monitoring continued. Suctioning sessions 2, 3, and 4 were handled in an identical manner to session I.

Phase III: Conditioned Response At least 30 minutes passed after the end of Phase II, before Phase III commenced. Phase III of the study consisted of one session of three trials during which the conditioned response was tested. Session 1 was identical to session 1 in Phase I: 5-minutes of baseline recording, the presentation of the tone (but no suctioning), and 5-minutes of post-tone recording.

At the end of Phase III, the infant was reconnected to the bedside monitor, the blood pressure transducer was recalibrated, and the study equipment was removed from the bedside.

Design:

A single-subject design was employed. The use of more than one subject is considered replication [16]. The design allows for observation of individual responses and permits consideration of data points that would be lost if traditional approaches such as averaging had been used. With continuous data collection, it is possible to look at trends and changes on a second-to-second basis following events.

In traditional group designs, individual variation among subjects may result in underestimating clinical effectiveness of treatments. The use of single-subject designs permits nurses to study the effectiveness of nursing interventions and permits nurses

to conduct research in settings where large sample sizes are unavailable [17], such as NICU.

Results:

Data were inspected and descriptive statistics obtained for heart rate, oxygen saturation, blood pressure and respirations. Graphs were generated for each variable in each trial of each session. These plots of data over time were examined and heart rate selected as the key variable for analyses on the basis of quality and completeness of data. The stability of each baseline in each session of every phase was assessed [16] and a stable section of at least 2 minutes selected where possible.

The main focus of analysis for the graphs was change in heart rate from the applicable baseline (for example, in Phase II-session 1, trial 1 was the appropriate baseline for trial 2 and 3 of the same phase and session). Mean baseline heart rate for a baseline was computed first, and then used to calculate change in heart rate for each remaining data point in trial 2 and 3 of the session. This new variable called heart rate change was plotted over time separately for each session and trial. The graphs were examined for inaccurate data, such as artifact obtained from movement and dislodged electrodes, and time of occurrence recorded.

Video recordings were played and events and infant behaviours documented along with the time at which they occurred on the tape. Documentation of events in this manner facilitated location of events and markers during subsequent examination and analysis. Using the real time stored in the computer data file and markers recorded in the computer and video records, the two databases (video and computer)

were matched.

Phase I. Graphs of change in heart rate for Phase I (trials 2 and 3 combined) are located in Figure 2 for the three subjects. The first trials, the initial baselines, have not been plotted since they were used to compute heart rate changes in subsequent trials. The horizontal reference lines indicate zero change from the mean baseline heart rate. The vertical axis represents the point at which the neutral stimulus was first presented. The vertical reference lines indicate the point at which the neutral stimulus (tone) ended. In no instance did heart rate rise or fall with the presentation of the conditioned stimulus tone in Phase I when it was a novel sound to the subjects. In all cases, heart rate patterns before during and after the tone were consistent.

Mean heart rates were computed for 20 seconds before and 20 seconds after any neutral stimulus tone in each non-suctioning session (Phase I, Phase III). These are presented in Table 1 along with mean heart rates for entire Trial 1 baselines (that is, not just the last 20 seconds). For each subject, the mean heart rates for the 20 seconds before and after the tone in Phase I were identical.

Phase II. Heart rate change graphs for Phase II are located in Figure 3 for all subjects. The vertical axis represents the presentation of the tone. The vertical reference line represents the end of the suctioning session. Figure 3 indicates that infants responded in unique ways to suctioning. Case A for example had a small drop in heart rate for the first suctioning, and a small increase for suction Session 4. In Session 2 there was an initial decrease after about 40 seconds followed by an increase

in heart rate.

Cases B and C responded to the suctioning procedures with 5 to 20 bpm increases in heart rate. The exception was the fourth suctioning for Case B. Heart rate was not stable during the Session 4 baseline (trial 1) before the tone. The heart rate trend during the baseline was one of an increasing rate. It remained elevated when the tone was presented and began to drop over the next 5 minutes before it rose with the fourth pass of the suction catheter and handling by staff.

The artifact during the initial part of the suction Session 3 for Case C likely arises from both movement of the infant and poor electrode connection. The same pattern was found before and after the tone.

Mean heart rates were also computed for the suctioning trials for the period of time from tone until the infant was suctioned or otherwise handled in preparation for suctioning (for example, touched or disconnection of the endotracheal tube from the ventilator circuit prior to the first pass of the suction catheter). Table 2 contains those means as well as the means for the Trial 1 baselines for suction Sessions 1 through 4.

Phase III. Phase III graphs of heart rate change following presentation of the tone (but no suctioning or handling) are located in Figure 4. Phase III represents the determination of a conditioned response. Case B demonstrated an immediate increase in heart rate with the presentation of the tone after a stable 4 minute baseline. This elevation continued for approximately 40 seconds before dropping to baseline. There was no handling or other noise (and of course, no preparation for suctioning) that coincided with this increase.

Heart rates for Case A and C did not change with the tone; the drop in heart rate after about 20 seconds for Case C and 70 seconds for Case A correspond to ringing alarms. The mean heart rates presented in Table 1 support the data in the graphs. Figure 5 presents heart rate over three trials of Phase III for Case B. Although the means suggest a trend of increasing heart rate, the graph does not.

Discussion:

The effect of the conditioning was assessed at Phase III of the study for each infant. Case B appeared to demonstrate a conditioned response not observed in the other infants. This was an immediate response to the tone which was sustained for about 40 seconds. The response could not be explained by other events (such as noise, handling, spontaneous movement by the infant, or a trend or heart rate increase). In an effort to examine all potential causes for this rise in heart rate, the blood pressure data was examined. This demonstrated a drop in arterial blood pressure (systolic, diastolic, and mean) that occurred immediately prior to the delivery of the tone. Figure 5 presents blood pressure data over three trials of Phase lll for Case B. A baroreceptor response is the most likely reason for the increase in heart rate that coincided with the presentation of the tone [18].

Clearly, neither Case A or C demonstrated a conditioned response. Case A also did not exhibit the anticipated unconditioned responses to endotracheal suctioning. Consequently, the basic assumption for creating a conditioned response (that is, having a unconditioned response to an unconditioned stimulus) was not met for this infant. This may be one explanation for the failure to demonstrate a

conditioned response to the tone for Case A.

The ability to successfully condition with this particular neutral stimulus may be dependent on several factors. One of these may be technical factors such as timing and sequencing of events. Perhaps the tone did not occur at the optimal time or in the correct sequence of events relative to the suctioning procedure, in order to condition the infants. While the tone was presented before the beginning of the suctioning, perhaps it was too far away from the suctioning to be effective. Correct timing of the event is known to be generally important, but the exact time the conditioned stimulus should occur before the unconditioned stimulus is not known [19]. As well, the tone may have been delivered at an insufficient volume for some infants since their hearing threshold in that environment was unknown.

Another factor which may explain ability to condition is individual infant factors such as attentiveness or sleep state at the time of the presentation of the tone and overall clinical condition. State of arousal prior to suctioning could explain lack of conditioned response. There is some evidence [20] to indicate infants may be unresponsive when events occur during a period of low arousal. It may also be that over-stimulated infants fail to habituate and then are unable to attend to stimuli like a neutral tone.

The single subject design of this study permitted a level of analysis which is not available in group designs. Averaged heart rates obliterate some important changes that occur following certain events or stimuli. The continuous measure of heart rate allowed identification of the increased heart rate corresponding with the

delivery of the tone in Phase lll for Case B, specifically that there was a discontinuity in data which occurred precisely at the time of the tone. The continuous recording of blood pressure provided a plausible explanation for this increase in heart rate which could not be explained by any other event. The mean heart rates, however, suggest a continuous upward trend in heart rate, which was not real.

The continuous data and accompanying video recordings indicated that infants responded to various noises in the NICU. Cases A and C, for example, responded with increased heart rates to alarms sounding in the NICU. This raises the question of the impact of the environment upon preterm infants staying in the NICU.

Conclusions:

The findings of this preliminary study did not demonstrate conditioned responses in preterm infants. Further research is warranted to further examine conditioned responses. It is recommended that the research take place in an environment which is more amenable to control than the bedside of the NICU. Demonstration of learned responses can be used to question traditional procedures and practices in the NICU, and to establish a more developmentally supportive environment. Another area deserving of investigation is the extent to which the NICU environment causes disruptions for infants.

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Figure 1: Phases, Sessions and Trials of the Study

PHASE I			PHASE II												PHASE III		
Baseline			Suctioning												Conditioned Response		
Session 1			Session 1			Session 2			Session 3			Session 4			Session 1		
Trials			Trials			Trials			Trials			Trials			Trials		
1	2	3	1	2	3	1	2	3	1	2	3		2	3	1	2	3

Phase I - Session 1: Baseline assessment
Phase II - Sessions 1-4: Four suctioning episodes
Phase III - Sessions 1-3: Three tests of conditioned response

Trial 1 - Baseline
Trial 2 - Tone (or tone followed by suctioning in the case of Phase II)
Trial 3 - Recovery

Figure 2: Baseline heart rate response to tone for all subjects

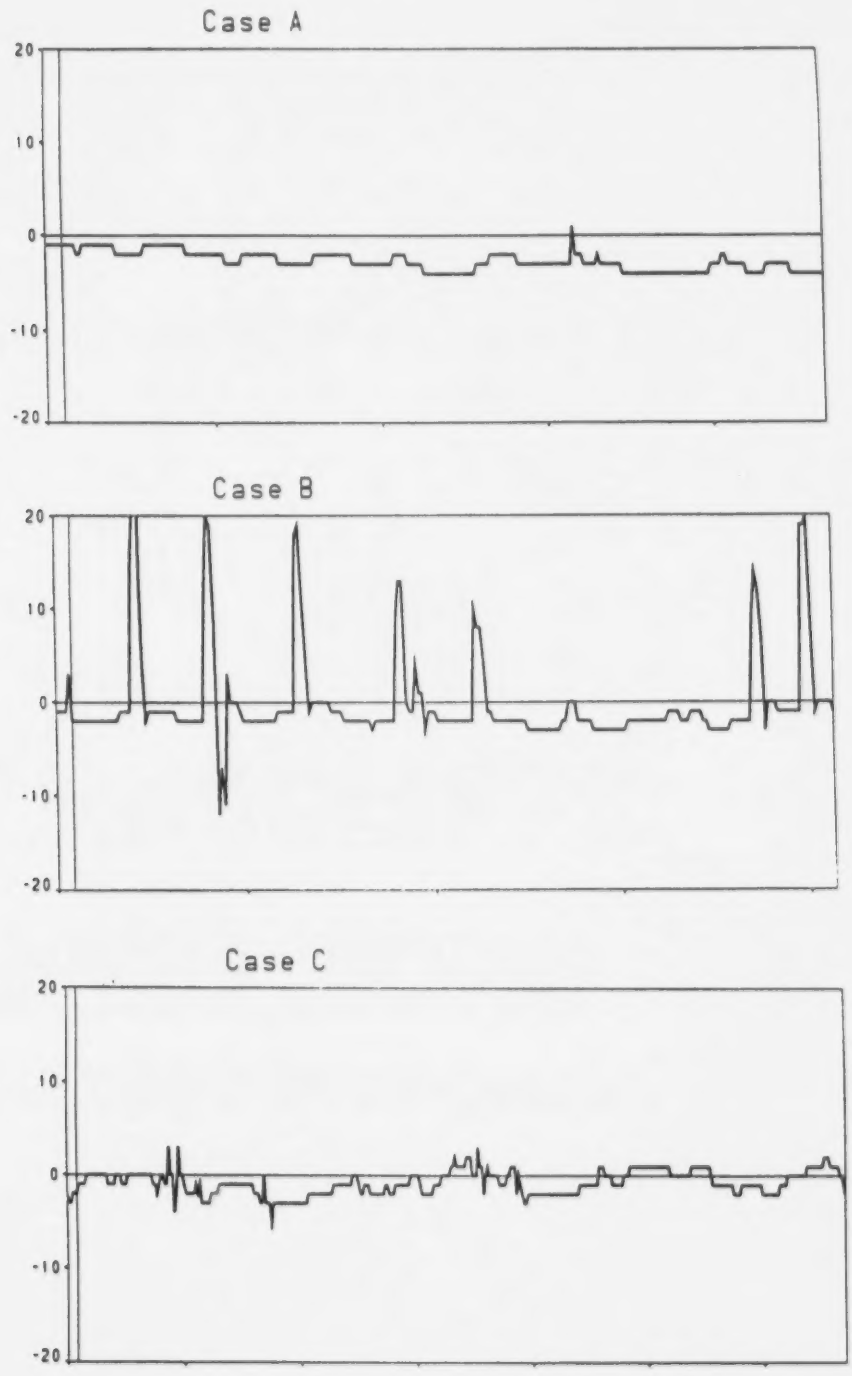

Figure 3: Heart rate change before, during and following four suction sessions.

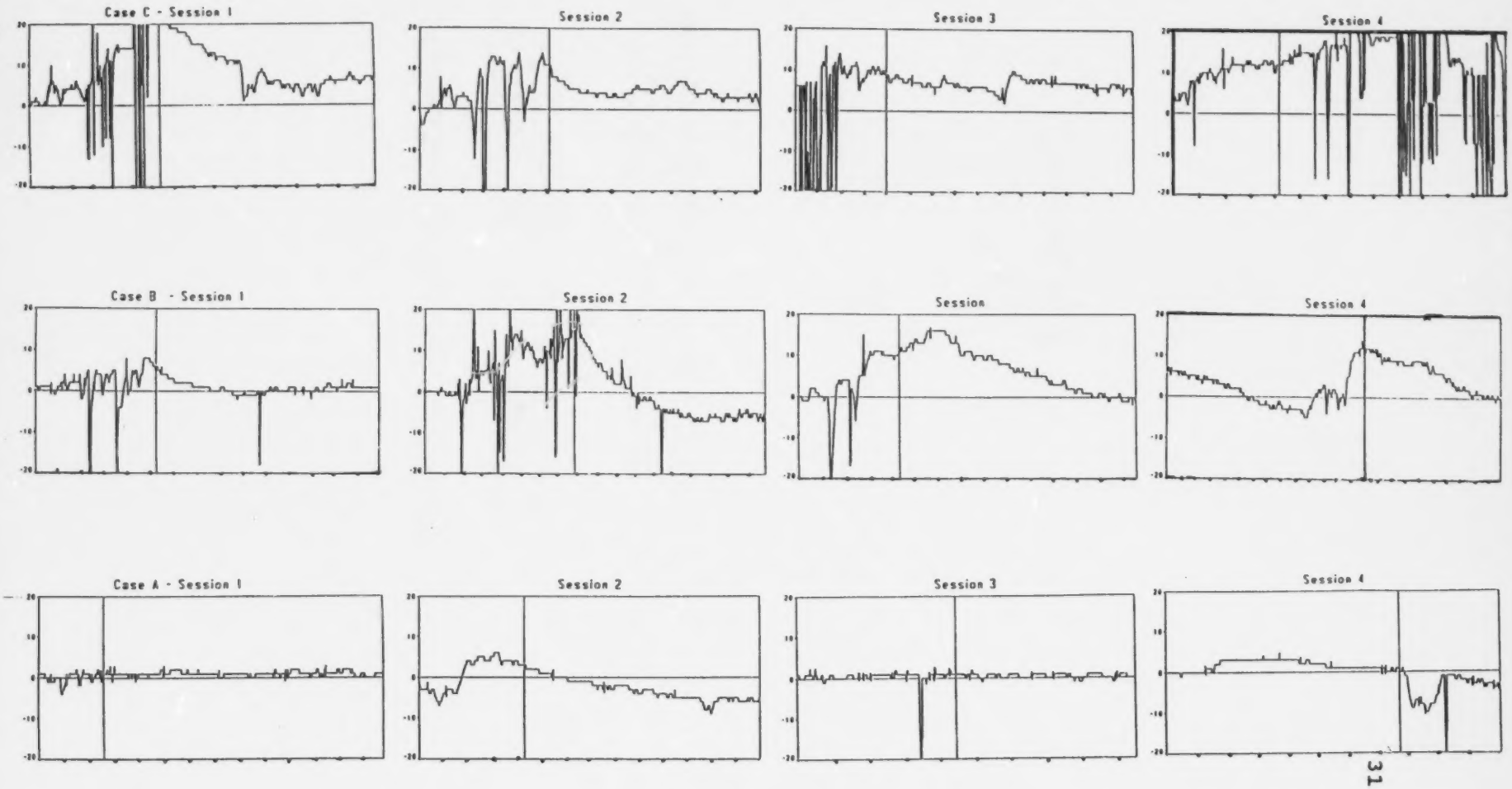

Figure 4: Heart rate response to test of conditioning - Phase III

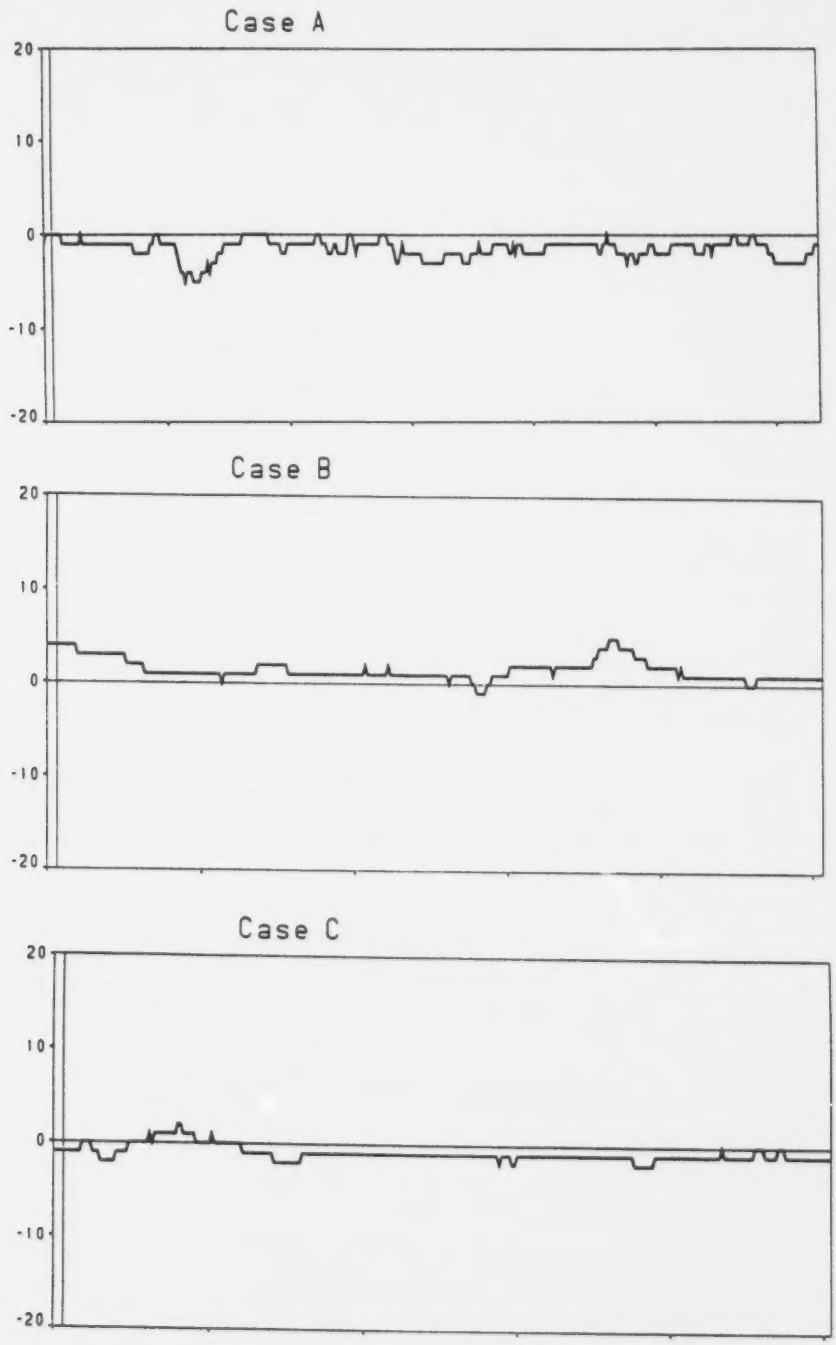

Figure 5: Case B - Heart rate and blood pressure before, during, and following conditioning session

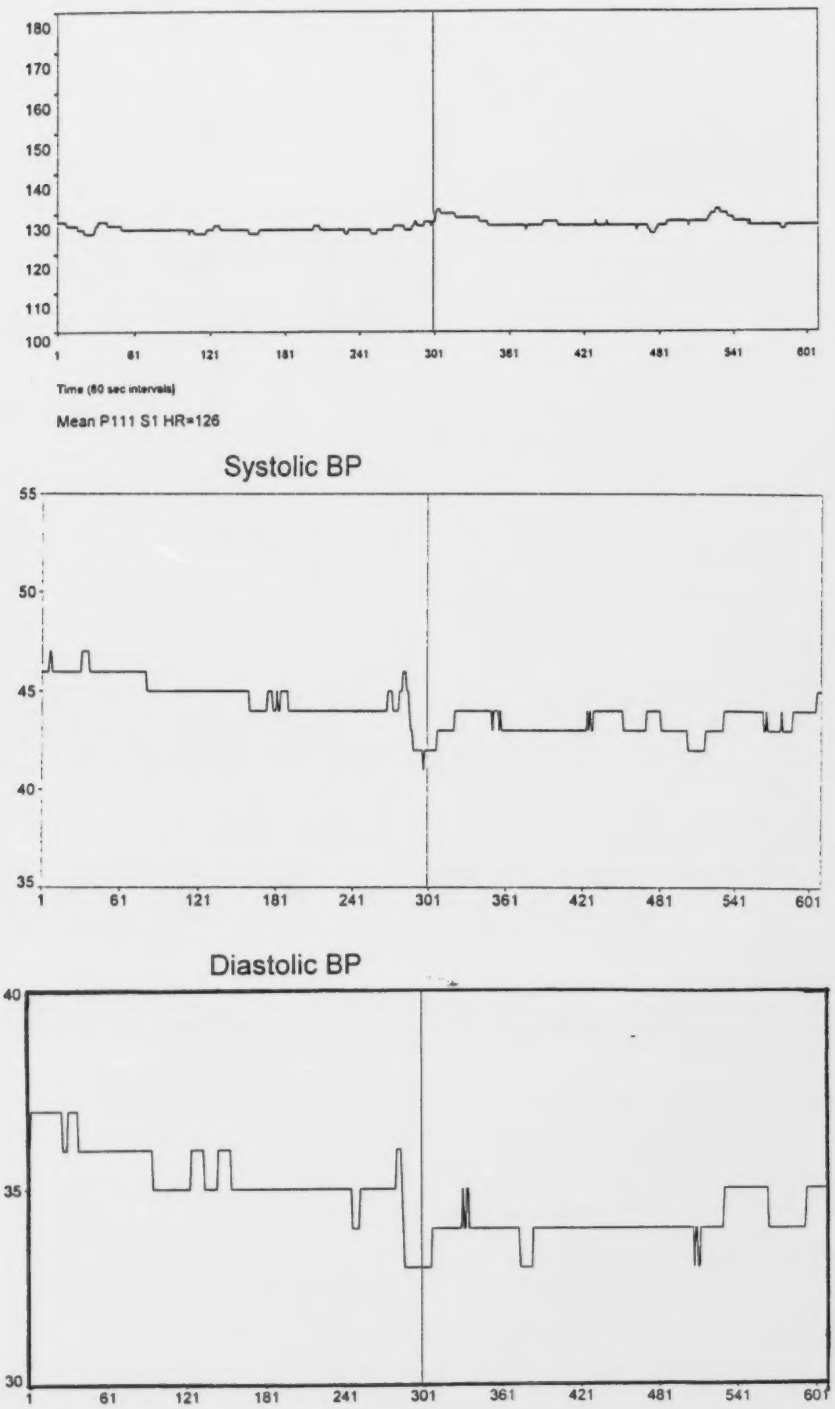

Table 1: Mean heart rate: Entire Trial 1 and 20 seconds before and after conditioned stimulus tone - Phases I and III [1]

Phase	Subject	Trial 1 Complete Trial	Trial 1 20 Seconds Before Tone	Trial 2 20 Seconds After Tone
I Session 1	A	138 (.91)	137 (.56)	137 (.40)
	B	150 (6.6)	148 (1.0)	148 (1.4)
	C	154 (.56)	154 (.51)	154 (.60)
III Session 1	A	135 (.54)	135 (.46)	134 (.46)
	B	126 (.91)	128 (1.4)	130 (.50)
	C	142 (1.3)	142 (1.7)	141 (.70)

[1] Standard deviation in parentheses.

Table 2: Four suction sessions: Mean heart rate Trial 1 (baselines) and Trials 2 - tone until subject first touched[1]

Suction Session	Subject	Trial 1	Trial 2[2]
1	A	132 (2.0)	131 (1.3)
	B	134 (1.1)	137 (.83)
	C	154 (1.1)	156 (1.8)
2	A	141 (3.0)	137 (1.4)
	B	135 (.40)	135 (.59)
	C	157 (1.2)	156 (1.6)
3	A	143 (3.8)	144 (.57)
	B	134 (.64)	134 (1.1)
	C	140(10.5)	140(10.5)
4	A	135 (1.4)	135 (.23)
	B	139 (4.2)	136 (.57)
	C	144 (1.0)	146 (.71)

1 Standard deviation in parentheses

2 Includes tone and preparation for suctioning until subject first touched

Responses of Preterm Infants to Environmental Stimuli

Abstract

Noise, handling and distressing procedures are recognized as sources of stress for the preterm infant in NICU. These stressors may lead to physiologic instability in preterm infants. Endotracheal suctioning, which is a common high risk procedure involving handling, was selected as the core procedure around which type and occurrence of potentially disruptive events would be described. Behavior and physiologic responses of infants during the study were also recorded.

Data were collected before, during, and after four endotracheal suctioning procedures for each of three preterm infants. Heart rate, blood pressure, respiration, and oxygen saturation were obtained at a rate of 1 per second. The infants were video-recorded during the data collection period. Over relatively brief recording intervals, numerous noxious and potentially distressing events were recorded. Infant responses to events were documented and described. Although generally aware of the need to reduce stimuli in the environment, staff did not use infant responses to interpret or adjust care for the infants in this study. Needs for reduction of environmental noise and use of infant responses to modify care were identified.

RESPONSES OF PRETERM INFANTS TO ENVIRONMENTAL STIMULI

Als[1] has theorized that the immature physiological system of the premature infant is unable to cope with the NICU environment in which care is provided. Therefore, the NICU can be a source of stress for critically ill infants. Light and noise (from people and equipment) may contribute to agitation and irritability in premature infants [1]. Besides the stress of the environment, many infants are exposed to potentially distressing procedures such as feeding tube insertions, intravenous cannulation, heelsticks, insertion and maintenance of endotracheal tubes, and asynchronous mechanical ventilation. These procedures are often associated with strange noises and handling. Together, the noises and the procedures contribute to a potentially detrimental physiologic instability in premature infants.

The preterm infant's brain is unable to handle sensory stimulation arising from the NICU environment[2]. Repeated exposure to excessive handling and distressing procedures can cause hypoxemia, and have long term consequences for the developing brain of the premature infant [3,4].

Endotracheal suctioning of premature infants is a common, high risk procedure. It poses a risk primarily because it may cause hypoxemia, increased intracranial pressure, atelectasis, pneumothorax, cardiac arrhythmias, and bacteremia [5,6,7] among others. It also may be a source of distress for infants. Despite these risks, infants must be suctioned to prevent occlusion of the endotracheal tube [3]. Since suctioning requires disturbing the infant, is a source of noise and a common procedure; it was selected as the focus of a recent study about infant conditioned

responses. The results of the study about conditioned responses are reported elsewhere. In this paper, we describe type and occurrence of potentially disruptive events as well as physiologic and behavioural responses of the infants.

METHODS:

The NICU in which this study was conducted is a level III, tertiary care unit receiving newborn infants from within the institution as well as a wide geographic area. This is a modern facility which was built 10 years ago. The NICU is a busy open-care area staffed with physicians, nurses, respiratory therapists, dieticians, social workers, housekeeping, and clerical staff. As well, there are many other individuals who provide services in the NICU intermittently (such as, x-ray and laboratory technicians).

Individual patient-care units contain an isolette or radiant-warmer bed, several monitors (each with alarms), IV pumps, supply storage cupboard with drawers and garbage and re-cycle bins. Some units will also have ventilators (with alarms), and may be near a phone and sink. Wall dividers run between rows of patient-care units but these are partial walls (about 1.5 m high) and they do not act as a barrier for noise. Indeed, monitors (equipped with alarms) have been placed on the top of the walls owing to a lack of space. The area is illuminated by ceiling florescent lights which cannot be adjusted in individual patient-care units. Some infants are exposed to additional light from phototherapy lamps.

Three NICU neonates who required periodic endotracheal tube suctioning were studied. All infants were studied within the first 24 hours of age. Subject A was a

female born at 29 weeks gestation following a cesarean section for maternal toxaemia and pulmonary edema. The infant's apgar scores were 4, 6, and 9. Within 3 hours of age, she was intubated, had an umbilical arterial line, and had received a dose of surfactant. Data collection commenced at 6 hours after birth.

Subject B was a female delivered vaginally at 27 weeks gestation following an induction for chorioamnionitis. Her apgar scores were 2 and 8. Data collection commenced 2 hours after birth. Intravenous bolus Midazolam was administered to this infant to manage agitation shortly after birth and after the commencement of data collection.

Subject C was a male infant born at 25 weeks gestation by spontaneous vaginal delivery. Apgar scores were 5 and 6. He required blood volume expanders and dopamine to manage hypotension but did not receive surfactant. Data collection commenced 5 hours after birth.

Observations of three infants were made before, during, and after suctioning, and were repeated over several suction procedures. Physiologic data (heart rate, blood pressure, respiratory rate and oxygen saturation) were collected by the Hewlett Packard Merlin monitor and transferred continuously to a computer for storage. Blood pressure was obtained via umbilical arterial catheter by a disposable transducer. A disposable Nellcor pulse oximetry probe was used with the Hewlett Packard pulse oximetry module of the Merlin monitor. The infant was video recorded throughout the study.

Data collection occurred before commencement of the infant's first suctioning

experience, with the first four suction procedures and following the fourth. Data collection was suspended during the 4-6 hour periods of time between suction procedures. The specific recording sessions were as follows:

- 10 minutes recording about 40 minutes before suction 1
- 5 minutes before, during and after each of 4 suction procedures (start of suction 1 and end of suction 4 were 15 to 17 hours apart)
- 30 minutes recording about 30 minutes after suction 4

Subjects were enrolled and studied one at a time.

ANALYSES:

Computer data were examined and organized into SPSS data files for analyses. Heart rate was selected as the primary variable for analysis based on quality and completeness of data. Video recordings were examined and notes made of all events that were recorded (of both sound and picture). The term events will be used to refer to handling, diapering, temperature taking, oral suctioning, and potentially disruptive noises. A description of these events was recorded as was the time that they occurred on the tape. Graphs of heart rate were generated by SPSS for all phases, subject by subject. The computer heart rate data and the video tapes were aligned so that events could be matched with physiologic data.

RESULTS:

Frequencies and types of events for the individual infants are presented in Table 1. The frequency of occurrence of any event for an infant is presented as well as the total for each infant and the duration of time that data were collected.

Infants A and C experienced 220 events and infant B 316 events. The mean number of events per minute of data collection were computed. These were: 2.1 (Subject A), 2.3 (Subject B) and 2.0 (Subject C) events per minute. These events ranged from handling and temperature taking to the noise of alarms and staff conversation. The most common were alarms (231 occurrences in total, during the entire data collection interval of 5 hours 53 minutes). Noises from the sinks, equipment, movement of the plastic tent and staff conversation were also frequent. Physiologic and behavioural responses to incidents and noises in the environment for individual infants are inventoried on Tables 2, 3 and 4. Table 5 presents percentages of events which resulted in a heart rate change. Infant activity was excluded from Table 5 since it is not independent of heart rate change.

DISCUSSION:

Over relatively brief data collection intervals, infants were exposed to numerous events. These events could be grouped as those related to noise or to treatment. Infants responded to a great many of these events with increased heart rate immediately after the event, suggesting a stimulus-response relationship. One question to be addressed is whether this rate of events (largely noisy events) is acceptable for the NICU.

Incidental Auditory Stimulation:

There is a substantial amount of noise in the NICU, some of it clearly unnecessary. Noises such as chairs sqeaking and garbage being thrown into a hard plastic container are readily removed by padding the garbage containers, and

maintaining or removing the chairs. Other noises observed can be quite readily reduced or eliminated. Noise, of course, is sensory stimulation and stimulation is generally regarded by practitioners to be detrimental for the premature infant. Nonetheless, the environment in this study provided a considerable amount of noise which was a source of stimulation for the infants who were studied.

Equipment alarms from ventilators, pulse oximeters, and intravenous pumps were one of the most frequent sources of noise. Frequently several alarms sounded at the same time, increasing the level of noise. Some alarms were unanswered for periods of time, for example false alarms due to monitor artifact when nurses were busy with other infants. Not only are unanswered alarms a hazard for infants, but create the risk of staff developing a deaf ear or habituating to alarms and not being available for an urgent situation.

Another concern with alarms is that the volume and tone of the alarm is not always consistent with the urgency of the situation. One example is the shrill alarm of the radiant warmer bed which muffled the sound of other more urgent alarms like the ventilator or the pulse oximeter. A need for research into the standardization and justification for the volume of alarms on monitoring equipment has been recently identified [8]. It is supported by the findings of this study.

Practices and Procedures:

Routine practices and procedures in the NICU make significant contributions to environmental noise. There were specific periods during the day that the noise of the NICU was great. These periods usually centred around the change of shift early in

the morning when there were extra staff present. At the same time of the day, housekeeping staff washed floors, emptied the garbage, and moved equipment, adding to the overall noise.

Other parts of the day were also noisy. Preparation of equipment for procedures and then disposal of materials in the garbage and recycling containers kept at the bedside were sources of noise. While a recycling program is important, its impact on noise levels should also be considered as should all new programs and equipment.

Procedures requiring handling occurred at irregular intervals by many different caregivers. Efforts were often made to soothe agitated infants such as restricting the infant's arms and legs when agitated. Although this handling was well intended, the infant's responses were not monitored and used to modify handling. Therefore, the handling often provided a source of distress in addition to that from the procedure and the general noise.

Changing wet diapers and temperature measurement (by axilla method) were the most frequently observed procedures during the periods of data collection. Some unnecessary handling was also observed, including diaper checks (handling the infant, undoing the diaper, raising the legs, and checking to see if diaper change was needed). One infant had a diaper checked on 3 occasions during a recording period for a suctioning session. Oral suctioning following endotracheal suctioning also occurred even though it is a known source of infant distress [9].

Technology has increased survival rates for low birth weight infants.

Technology has also created the NICU environment described in this paper. Improving environmental conditions and providing developmental care for these infants has potential to improve neurodevelopmental outcomes [10]. There are costs associated with not providing care in a developmentally supportive fashion. It has been suggested that developmentally supportive care, that is care that takes into account the infants responses and attempts to minimize stress and stimuli, has the potential to reduce the length of stay in NICU settings and reduce potential morbidity associated with BPD (bronchopulmonary dysplasia), ROP (retinopathy of prematurity), and IVH (intraventricular hemorrhage)[10,11,12].

Recommendations from this study include education for all staff working in the NICU setting regarding noise levels and their effects on preterm infants, ongoing monitoring of the environment and the use of an interdisciplinary developmental care approach for the NICU. All NICU staff must be aware of the consequences of aversive stimuli on preterm infants and care should be organized to minimize or eliminate such stimuli and optimize outcomes for preterm infants. Providing advanced preparation to key individuals in the NICU in Assessment of Preterm Infant Behavior (APIB) or the Neonatal Individual Developmental Care and Assessment Program (NIDCAP) [13] will help to achieve this aim.

New practices and procedures should be evaluated for potential contributions to environmental noise and infant responses. The video recording technique used in this study has great potential for use in the education of staff and management of care in the NICU. The video recordings of a particular infant can be used to monitor noise

and unnecessary handling. They can serve as a focus for staff discussions about improving care. They can also be used to assess and evaluate the effectiveness of interventions to improve the environment. An interdisciplinary approach to care can be holistic and effective.

Biomedical engineers, key people in eliminating or reducing environmental noise, can investigate and offer unique solutions to problems with equipment. They can evaluate equipment prior to purchase to assure that it meets requirements for a quiet environment. They can recommend adjustment of other equipment. Alarms for various pieces of equipment may have their volume reduced, or the volume may be muffled. Isolette doors and bedside drawers can be padded. The volume of the telephone ring can be reduced, and chairs that squeak should be properly maintained or removed from the area. Garbage cans and recycling bins can be padded.

Equipment manufacturers and federal agencies regulating medical equipment can be lobbied to set new guidelines for equipment. In particular, they can consider the effects of loud alarms on preterm infants as well as staff in the NICU.

All of these steps can be taken to improve the environment to promote optimal development of preterm infants in the NICU. Ultimately, further research is indicated to examine environmental influences on these vulnerable infants.

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Table 1: Type and Frequency of Events by Subject

EVENTS	Subjects			Total Events	Each Event % Grand Total
	A	B	C		
Handling	1	6	17	24	3.2
Diapering	1	2	1	4	0.5
Temperature taking	2	3	2	7	0.9
Oral suction	1	4		5	0.7
NOISE					
Suction	1	1	3	5	0.7
Equipment	21	32	17	70	9.3
Garbage	12	29	5	46	6.1
Recycling	3	21	7	31	4.1
Plastic tent	12	16	28	56	7.4
Coughing	3		1	4	0.5
Laughter	2	3	2	7	0.9
Staff talking	21	23	8	52	6.9
Infants crying	9	16	8	33	4.4
Sink	27	34	16	77	10.2
Drawer slamming	3	4	5	12	1.6
Chairs squeaking	10	12	6	28	3.7
Floor washer	7	2	5	14	1.8
Phone	14	17	13	44	5.8
Pagers	3	2	1	6	0.8
Alarms	67	89	75	231	30.6
Total Events	220	316	220	756	100
Recording Time(Min: Sec)	106:20	138:43	108:48	353:51	

Table 2: Responses to Environmental Stimuli, Subject A Responses

EVENTS	Total	HR ↑ 2-3	HR↓ 2-3	HR↑ 4-5	HR↓ 4-5	HR↑ > 10	HR↓ >10	STARTLE	MOVEMENT
Handling	6	1	1	1		2	1		1
Diapering	2		1				1		
Temperature taking	3								
Oral suction	4			2	1				
NOISE									
Suction	1								
Equipment	32	4	7	4	2				
Garbage	29	4	12				1		
Recycling	21	10	2				1		
Plastic tent	19	4	3	3		1	1		1
Coughing									
Laughter	3	1	1						
Staff talking	23	12	4			1		1	2
Infants crying	16	7	2			1			
Sink	34	5	23			1			2
Drawer slamming	4	1	3						
Chairs squeaking	12	5	4						
Floor washer	2	1							
Phone	17	5	6						
Pagers	2		1						
ALARMS	89	30	16	2	2	1			
TOTAL EVENTS	316	90	86	12	5	7	5	1	6

Table 3: Responses to Environmental Stimuli, Subject B

Responses

EVENTS	Total	HR ↑ 2-3	HR ↓ 2-3	HR ↑ 4-5	HR ↓ 4-5	HR ↑ > 10	HR ↓ >10	STARTLE	MOVEMENT
Handling	6	1	1	1		2	1		1
Diapering	2		1				1		
Temperature taking	3								
Oral suction	4			2	1				
NOISE									
Suction	1								
Equipment	32	4	7	4	2				
Garbage	29	4	12				1		
Recycling	21	10	2				1		
Plastic tent	19	4	3	3		1	1		1
Coughing									
Laughter	3	1	1						
Staff talking	23	12	4			1		1	2
Infants crying	16	7	2			1			
Sink	34	5	23			1			2
Drawer slamming	4	1	3						
Chairs squeaking	12	5	4						
Floor washer	2	1							
Phone	17	5	6						
Pagers	2		1						
ALARMS	89	30	16	2	2	1			
TOTAL EVENTS	316	90	86	12	5	7	5	1	6

Table 4: Responses to Environmental Stimuli, Subject C

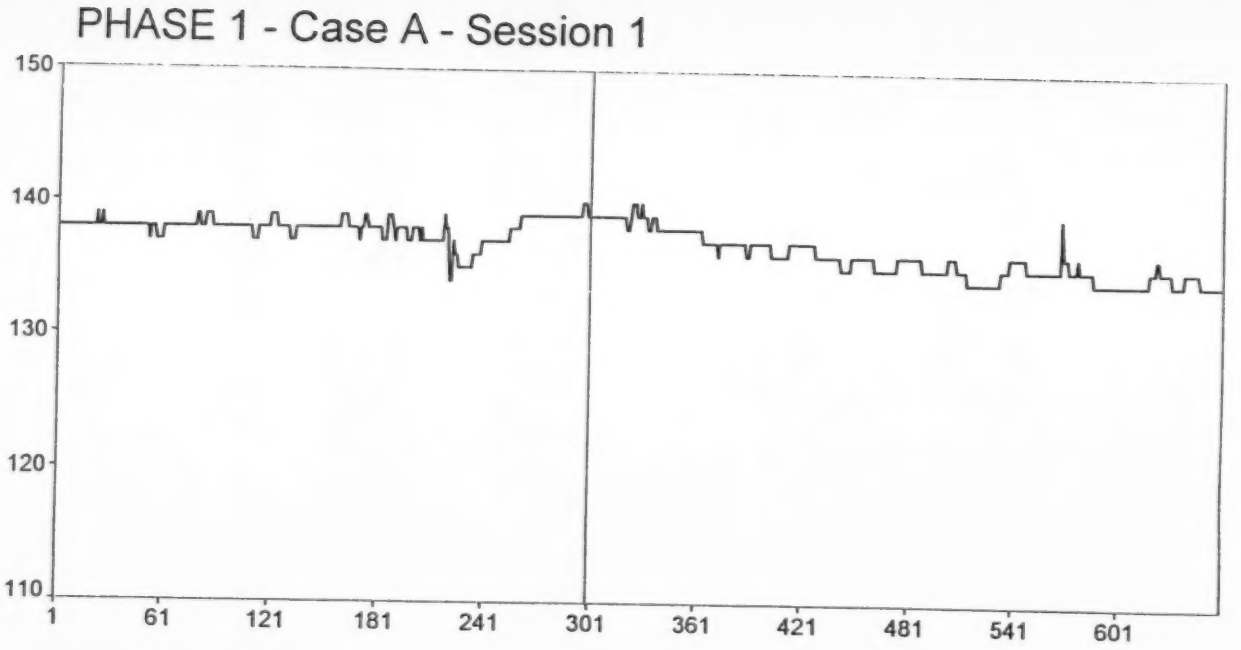
Responses

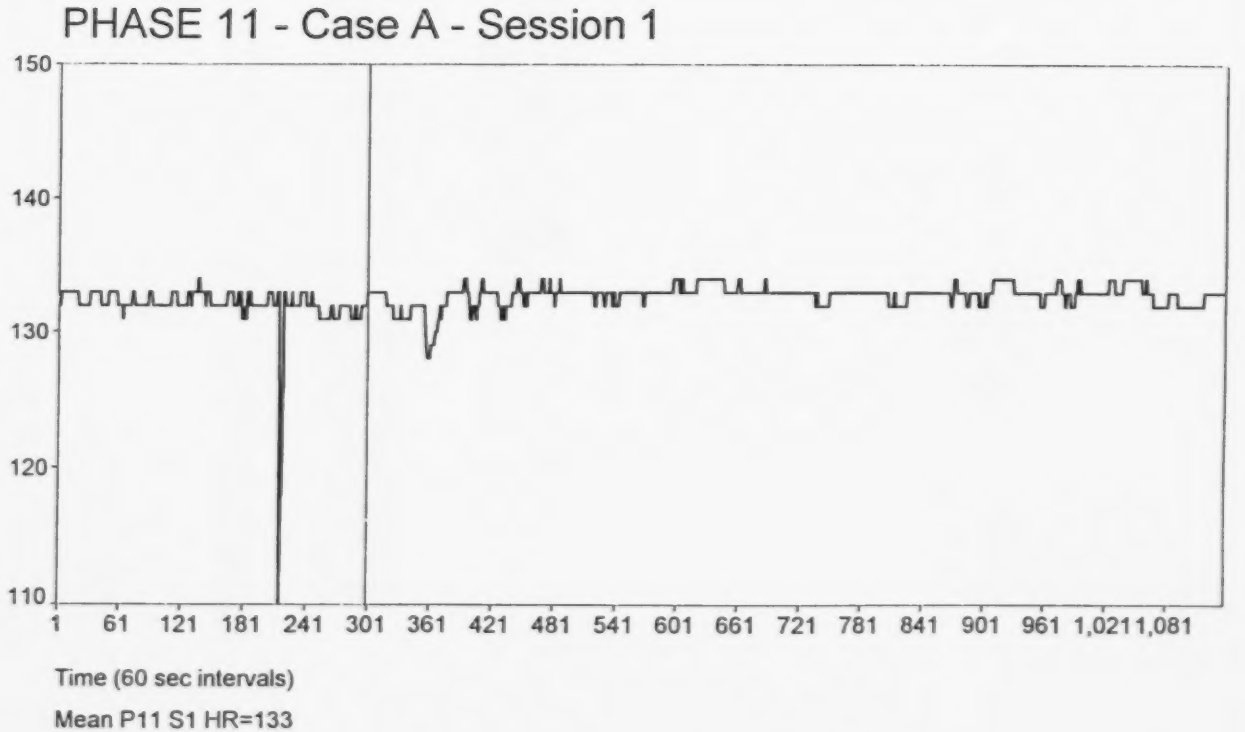
EVENTS	Total	HR ↑ 2-3	HR ↓ 2-3	HR ↑ 4-5	HR ↓ 4-5	HR ↑ > 10	HR ↓ >10	STARTLE	MOVEMENT
Handling	17	4	3	1	1	1	1		17
Diapering	1								1
Temperature taking	2								2
Oral suction									
NOISE									
Suction	3	1							1
Equipment	17	6	3						
Garbage	5	2	1	1					1
Recycling	7	4	1		1				1
Plastic tent	28	14	4	2		1	1	1	6
Coughing	1	1							
Laughter	2	2							
Staff talking	8	4		1				2	
Infants crying	8	4	1						
Sink	16	4	3					1	
Drawer slamming	5		2			1			
Chairs squeaking	6	1	3						
Floor washer	5			2					
Phone	13	4	4						
Pagers	1								
Alarms	75	14	17	2					6
TOTAL EVENTS	220	65	42	9	2	3	2	4	35

Table 5: Percent of events for which each infant responded

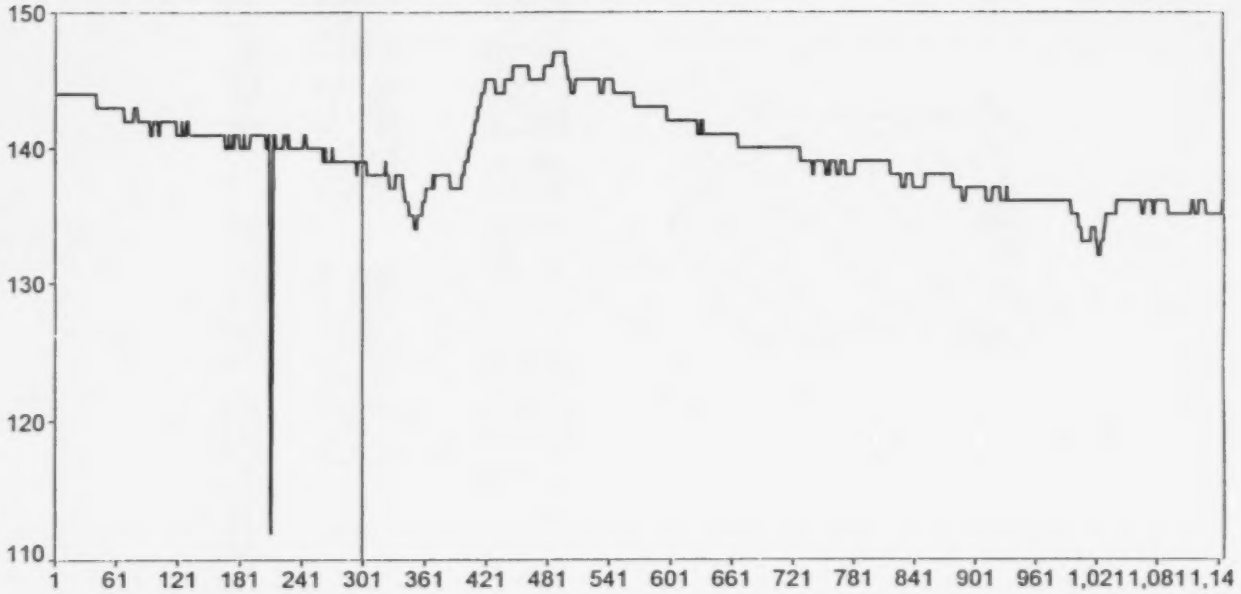
	Subject A	Subject B	Subject C
Incidents			
Handling	100% (1)	100% (6)	65% (17)
Diapering	0% (1)	100% (2)	0% (1)
Temperature taking	0% (2)	0% (3)	0% (2)
Oral Suction	100% (1)	75% (4)	(0)
Noise			
Suction	100% (1)	0% (1)	33% (3)
Equipment	100% (21)	53% (32)	53% (17)
Garbage	100% (12)	59% (29)	80% (5)
Recycling	100%(3)	62% (21)	86% (7)
Plastic tent	42% (12)	63% (19)	79% (28)
Coughing	100% (3)	(0)	100% (1)
Laughter	100% (2)	66% (3)	100% (2)
Staff talking	48% (21)	74% (23)	62% (8)
Infants crying	11% (9)	62% (16)	62% (8)
Sink	78% (27)	85% (34)	44% (16)
Drawer slamming	66% (3)	100% (4)	60% (5)
Chairs squeaking	80% (10)	75% (12)	67% (6)
Floor washer	71.4% (7)	50% (2)	40% (5)
Phone	64% (14)	76% (17)	62% (13)
Pagers	0% (3)	50% (2)	0% (1)
Alarms	57% (67)	57% (89)	44% (75)
Total	220	316	220

Appendix A


PHASE 1 - Case A - Session 1
150
140
130
120
110
1
61
121
181
241
301
361
421
481
541
601
Time (60 sec intervals)
Mean P1 HR=137

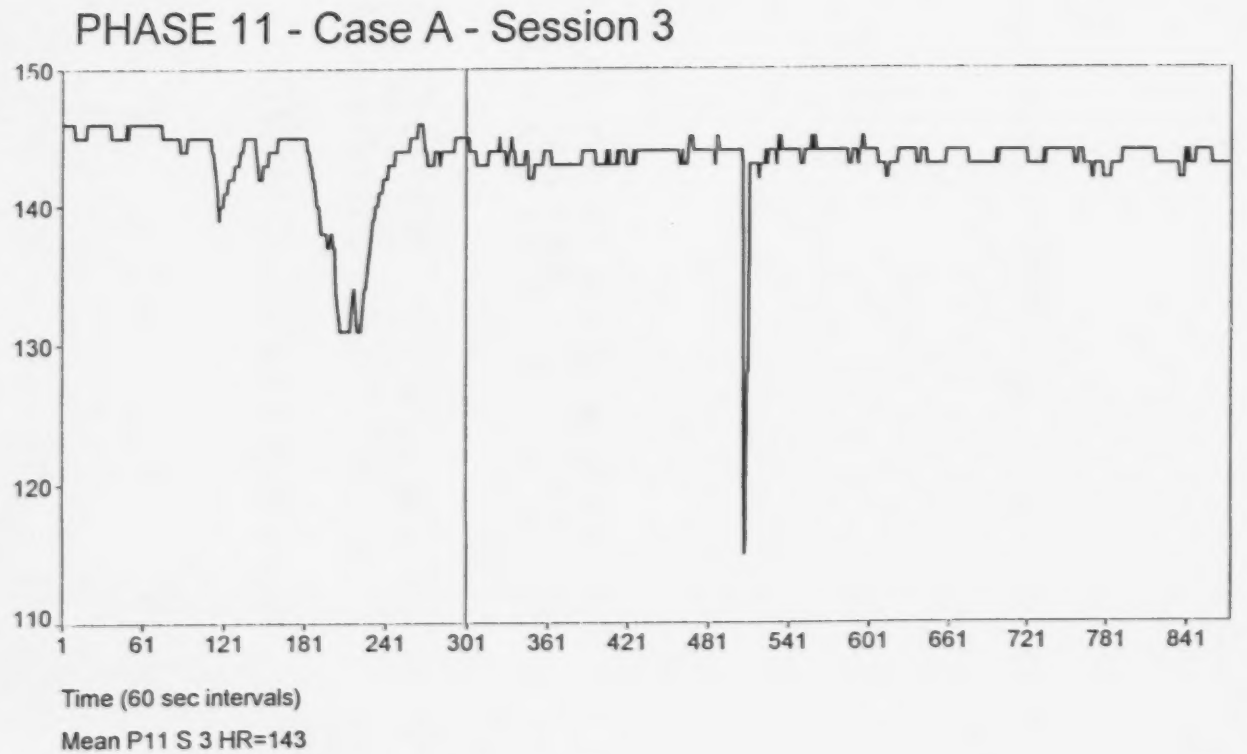

PHASE 11 - Case A - Session 1
150
140
130
120
110
1
61
121
181
241
301
361
421
481
541
601
661
721
781
841
901
961
1,021
1,081
Time (60 sec intervals)
Mean P11 S1 HR=133

PHASE 11 - Case A - Session 2

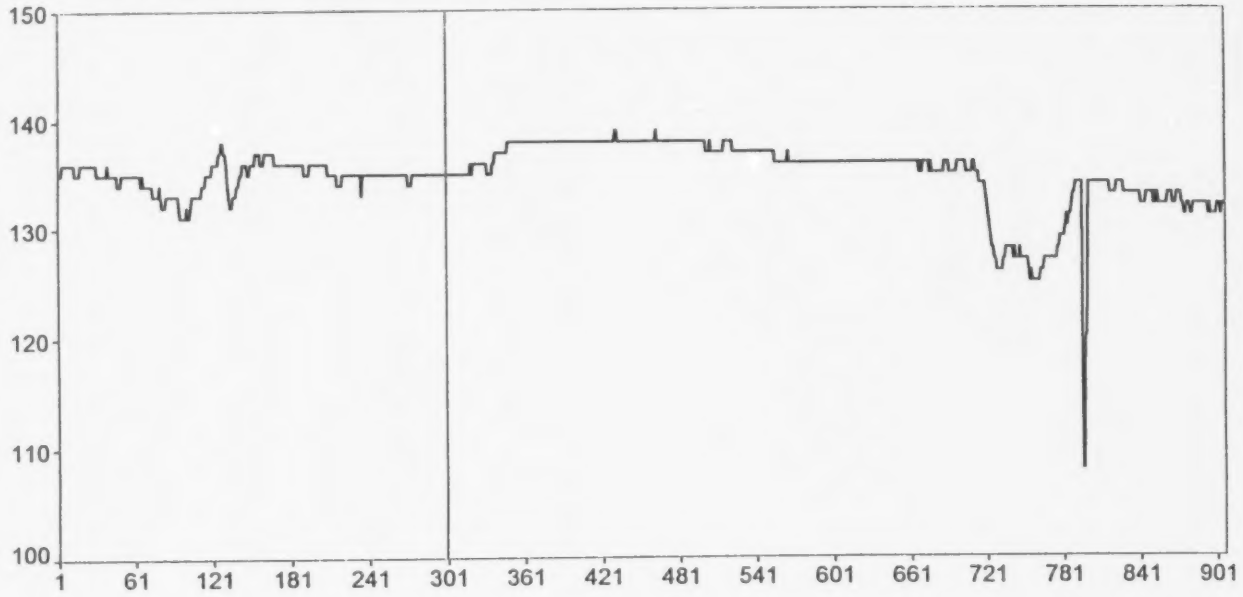


Time (60 sec intervals)

Mean P11 S2 HR=140

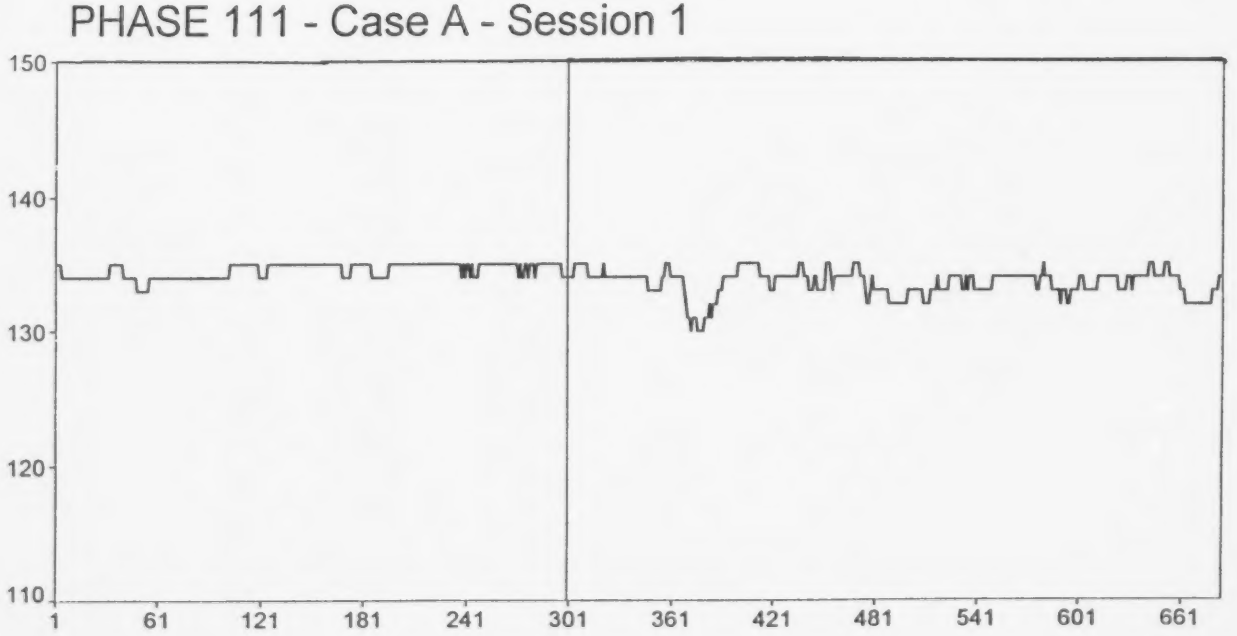

PHASE 11 - Case A - Session 3
150
140
130
120
110
1
61
121
181
241
301
361
421
481
541
601
661
721
781
841
Time (60 sec intervals)
Mean P11 S 3 HR=143

PHASE 11 - Case A - Session 4

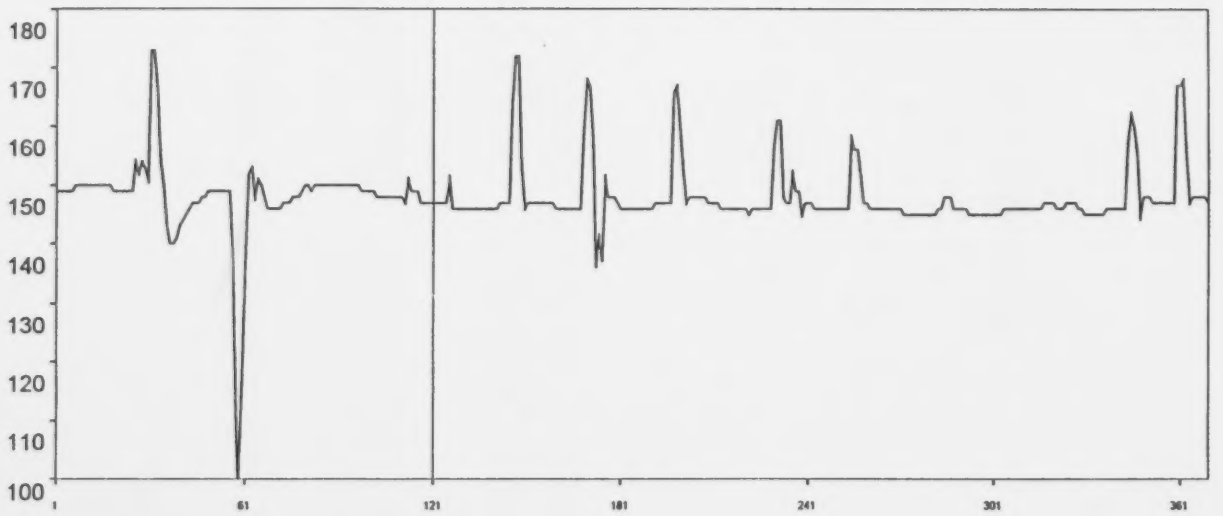


Time (60 sec intervals)

Mean P11 S4 HR=135

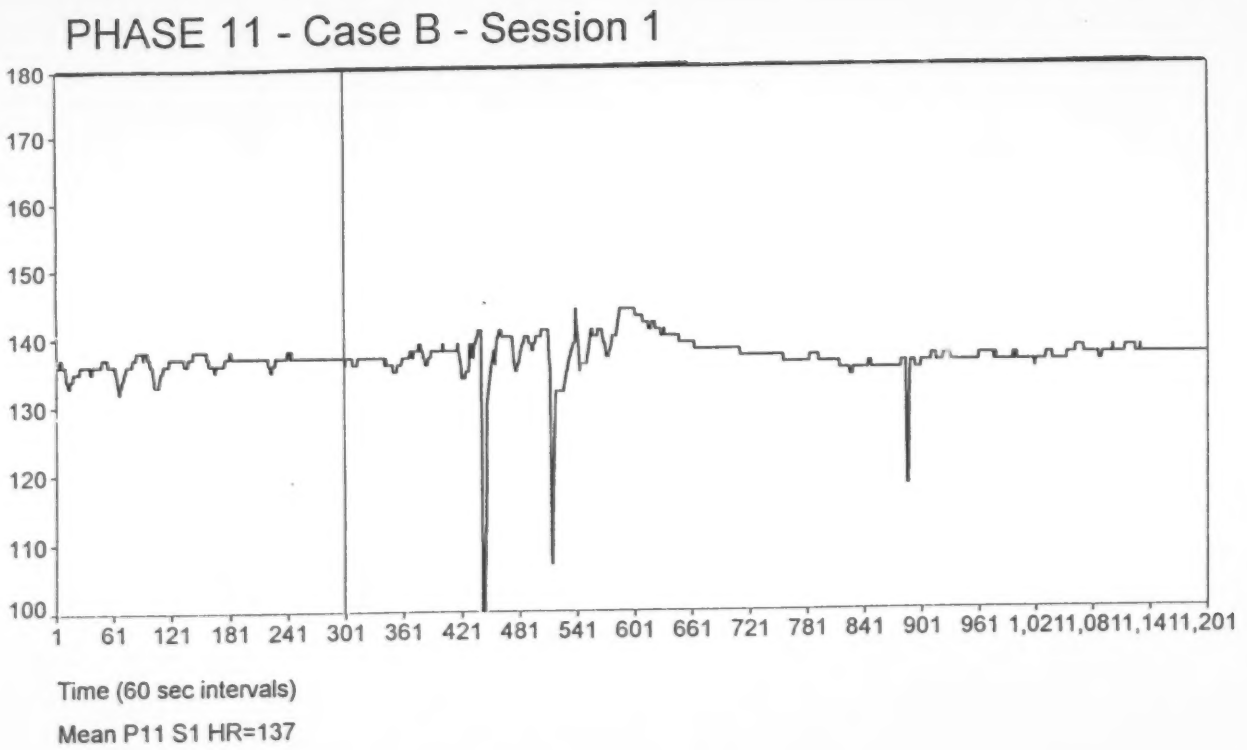

PHASE 111 - Case A - Session 1
150
140
130
120
110
1
61
121
181
241
301
361
421
481
541
601
661
Time (60 sec intervals)
Mean P111 S1 HR=134

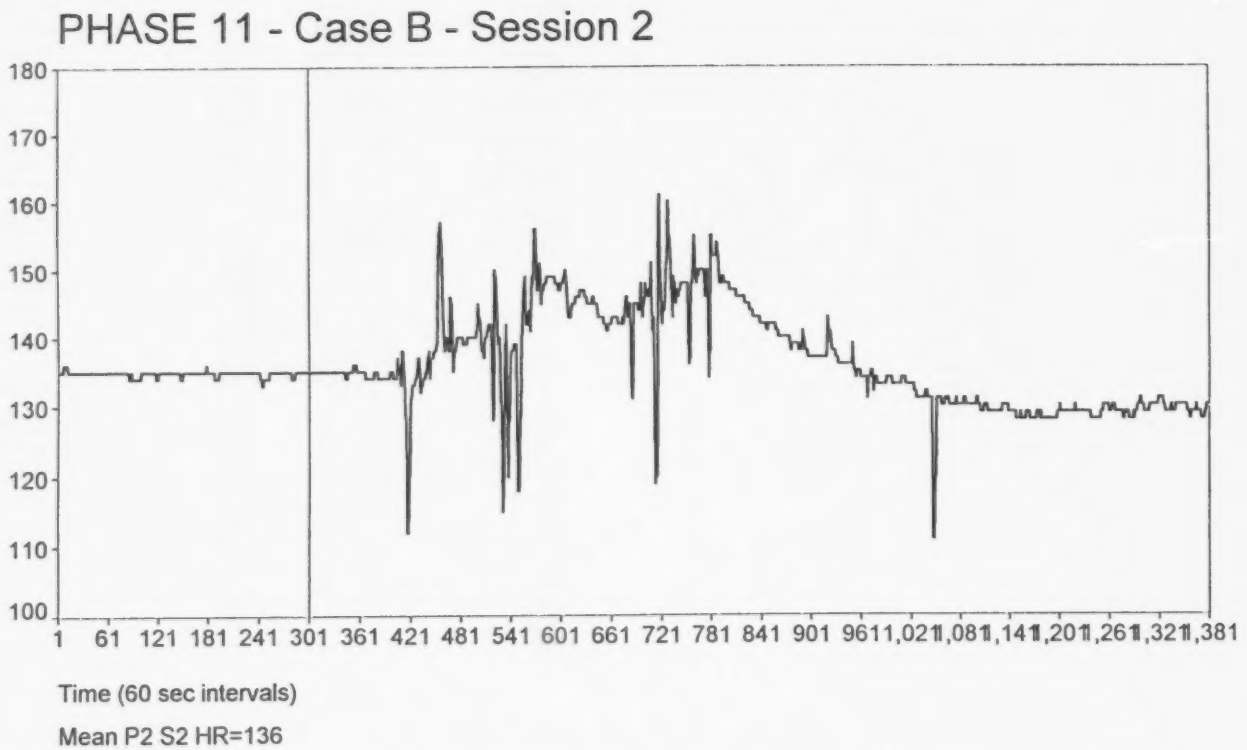
PHASE 1 - Case B - Session I

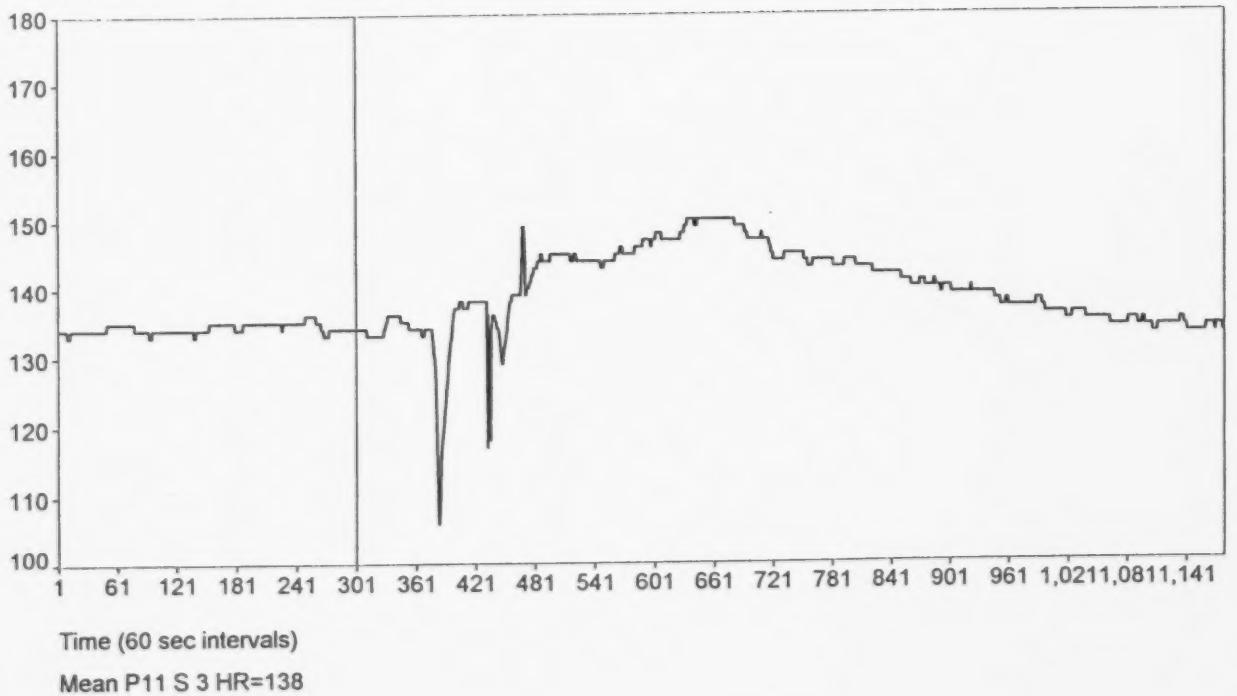


Time (60 sec intervals)

Mean PI HR=148


PHASE 11 - Case B - Session 1
180
170
160
150
140
130
120
110
100
1
61
121
181
241
301
361
421
481
541
601
661
721
781
841
901
961
1,021
1,081
1,141
1,201
Time (60 sec intervals)
Mean P11 S1 HR=137


PHASE 11 - Case B - Session 2
180
170
160
150
140
130
120
110
100
1 61 121 181 241 301 361 421 481 541 601 661 721 781 841 901 961 1,021 1,081 1,141 1,201 1,261 1,321 1,381
Time (60 sec intervals)
Mean P2 S2 HR=136

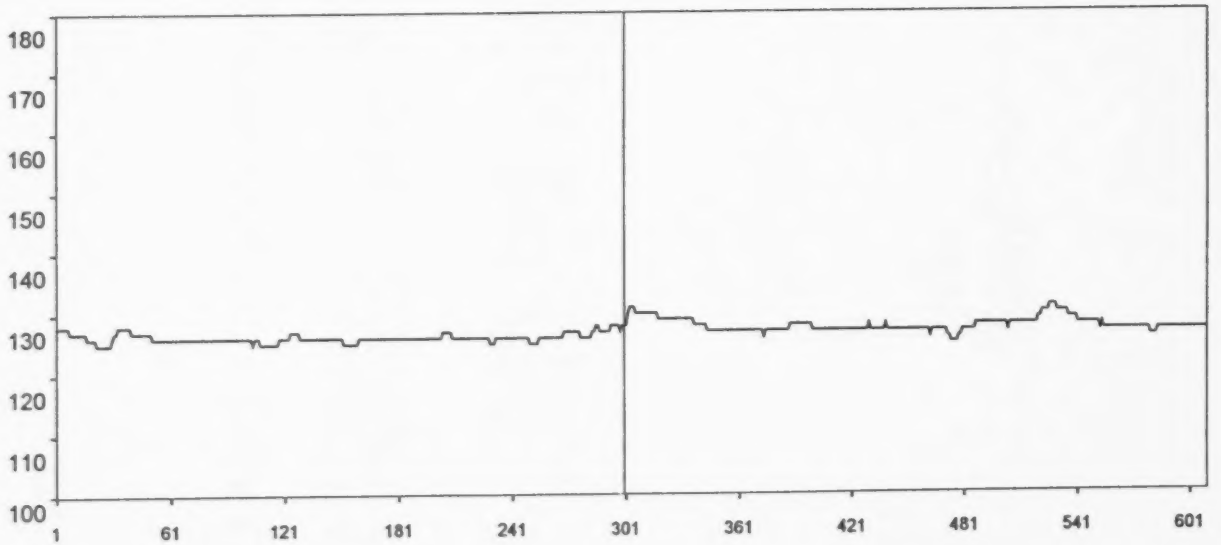

PHASE 11 - Case B - Session 3
180
170
160
150
140
130
120
110
100
1
61
121
181
241
301
361
421
481
541
601
661
721
781
841
901
961
1,021
1,081
1,141
Time (60 sec intervals)
Mean P11 S 3 HR=138

PHASE 11 - Case B - Session 4

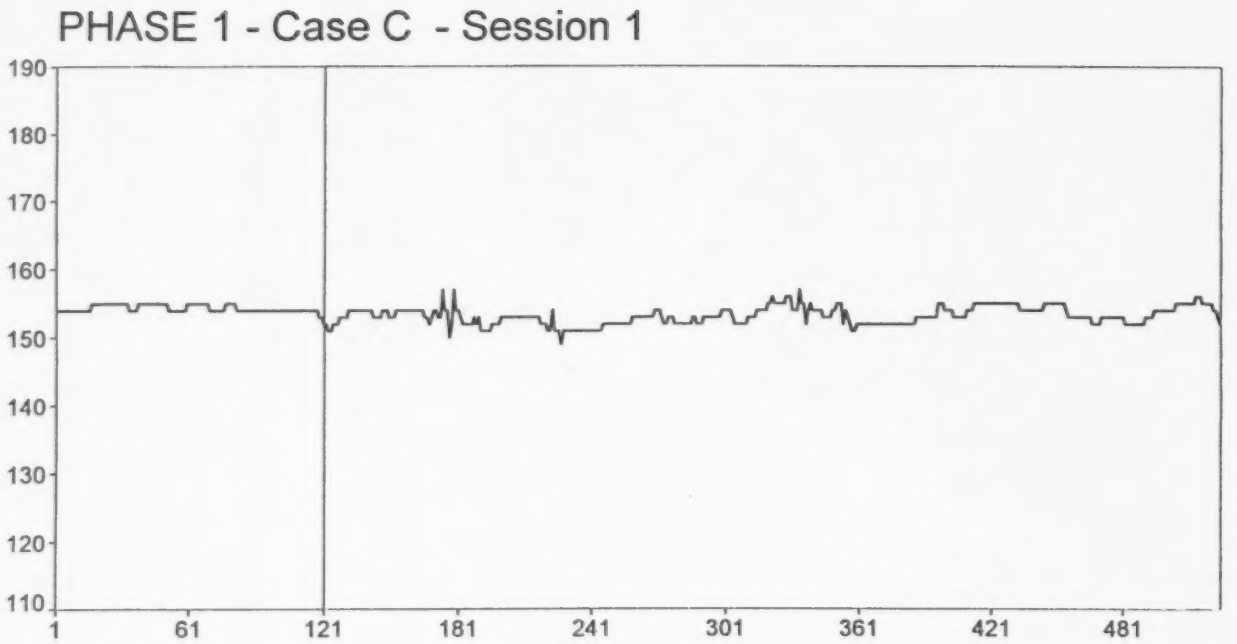
Time (60 sec intervals)

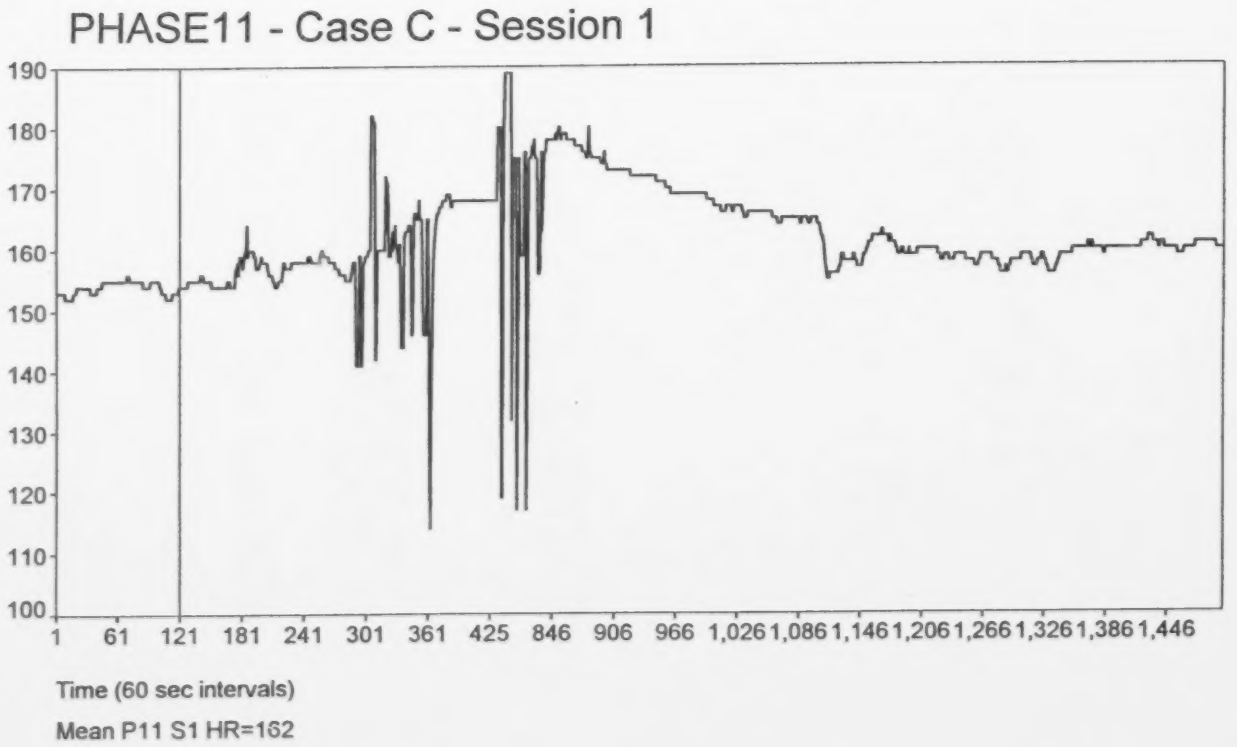
Mean P11 S4 HR=133

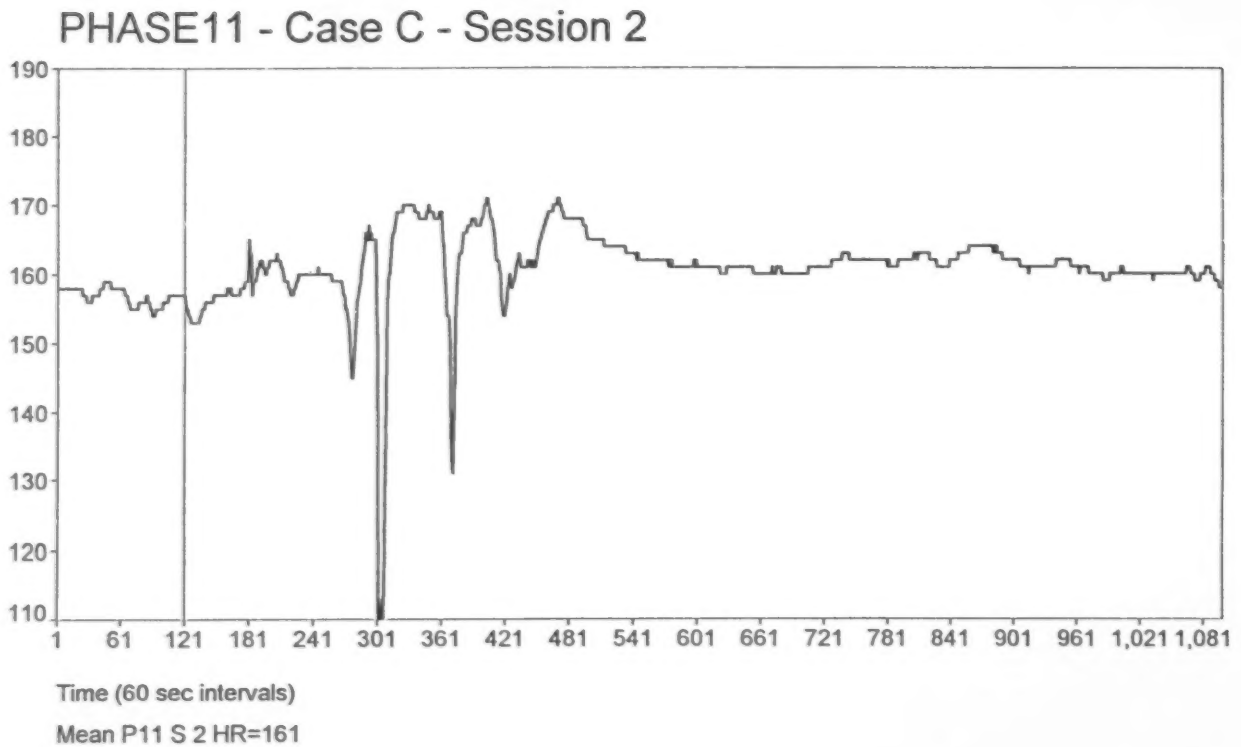
PHASE III - Case B - Session 1



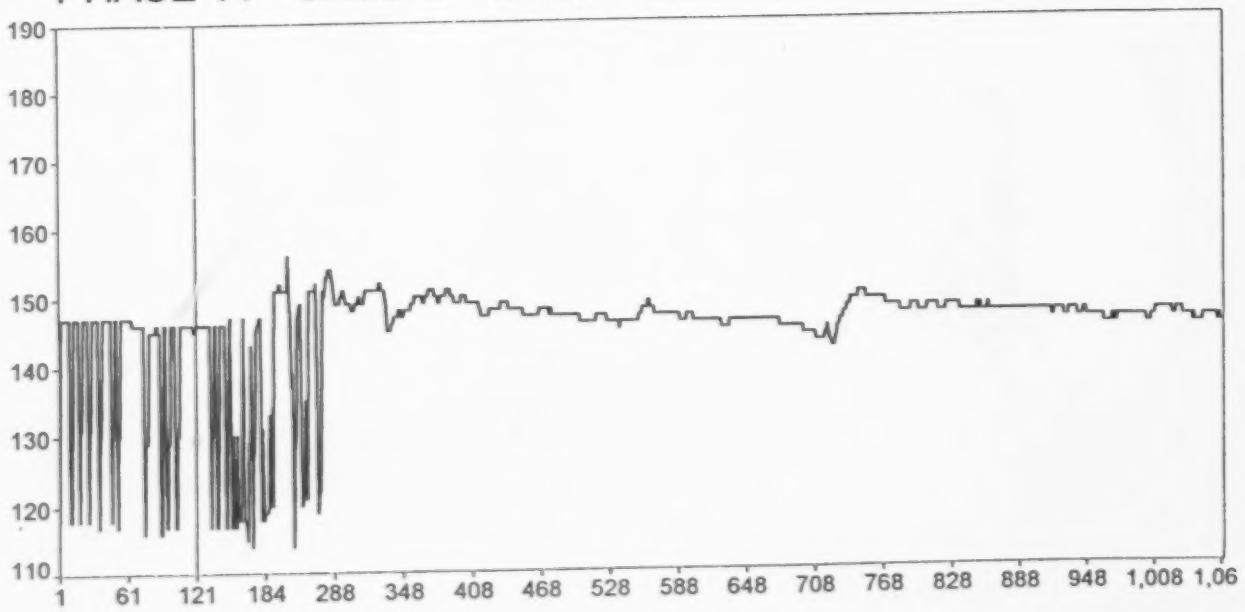
Mean P111 S1 HR=126


PHASE 1 - Case C - Session 1
190
180
170
160
150
140
130
120
110
1
61
121
181
241
301
361
421
481
Time (60 sec intervals)
Mean P1 HR=154


PHASE11 - Case C - Session 1
190
180
170
160
150
140
130
120
110
100
1
61
121
181
241
301
361
425
846
906
966
1,026
1,086
1,146
1,206
1,266
1,326
1,386
1,446
Time (60 sec intervals)
Mean P11 S1 HR=162

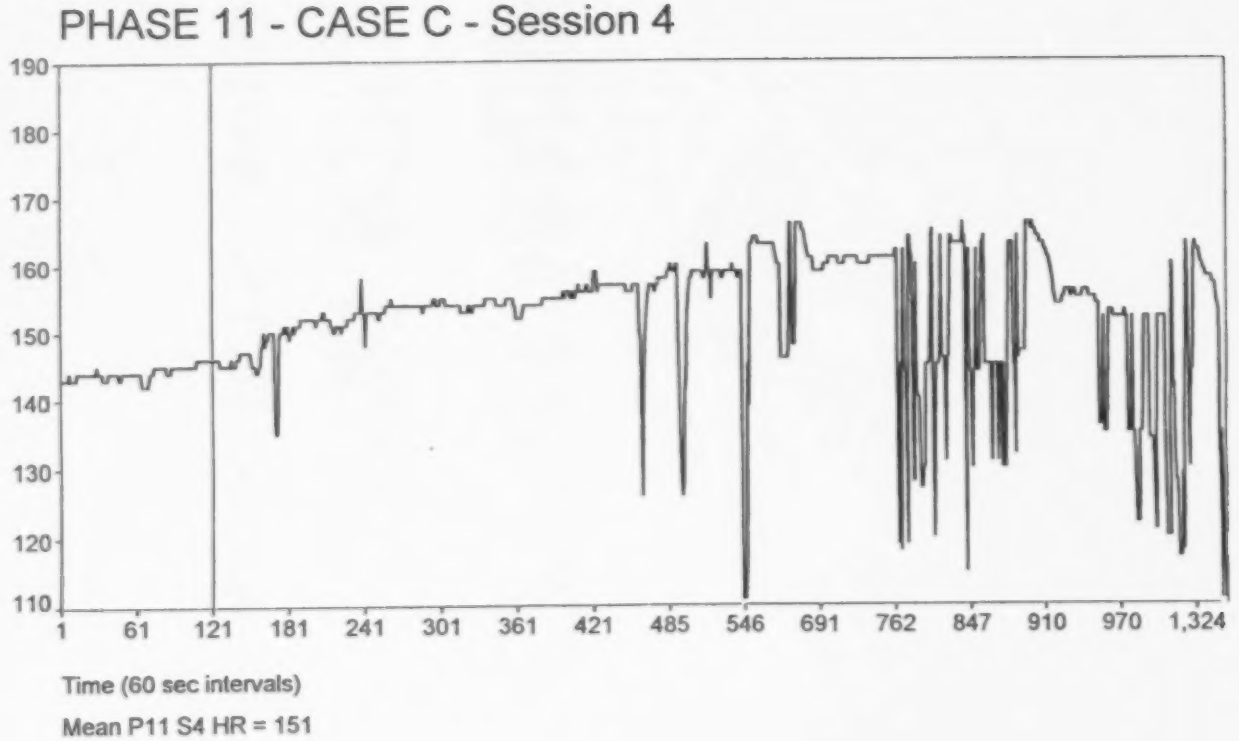

PHASE11 - Case C - Session 2
190
180
170
160
150
140
130
120
110
1
61
121
181
241
301
361
421
481
541
601
661
721
781
841
901
961
1,021
1,081
Time (60 sec intervals)
Mean P11 S 2 HR=161

PHASE 11 - CASE C - Session 3

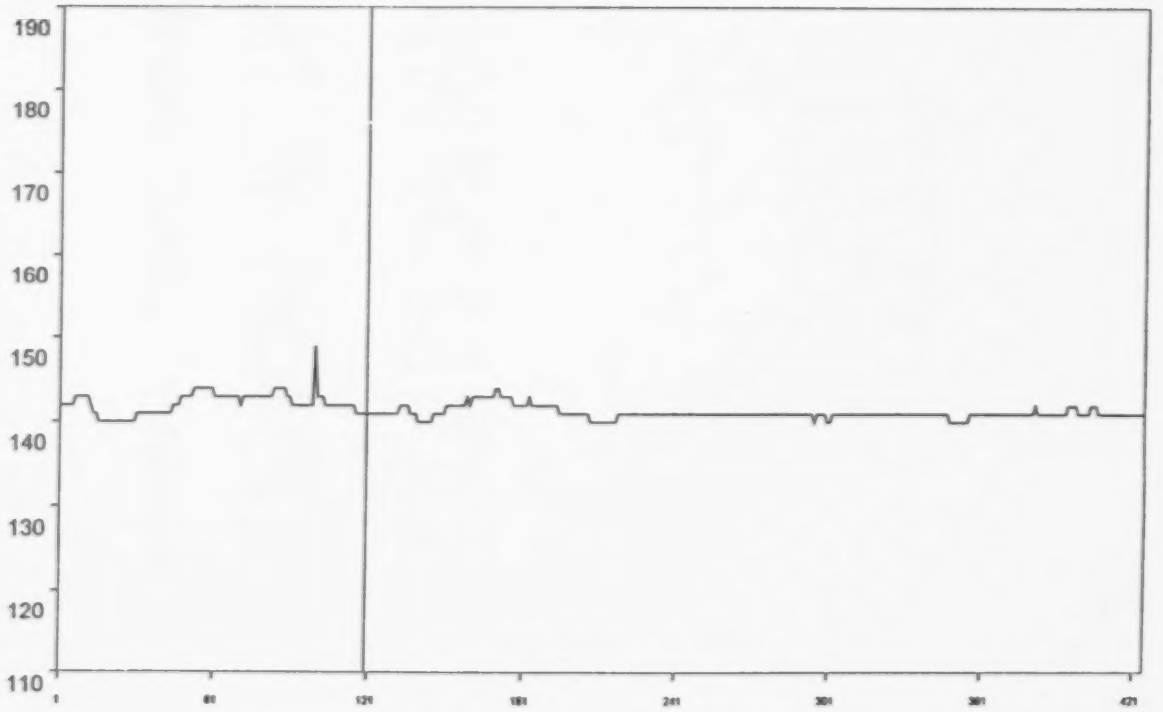


Time (60 sec intervals)

Mean HR P11 S 3=145

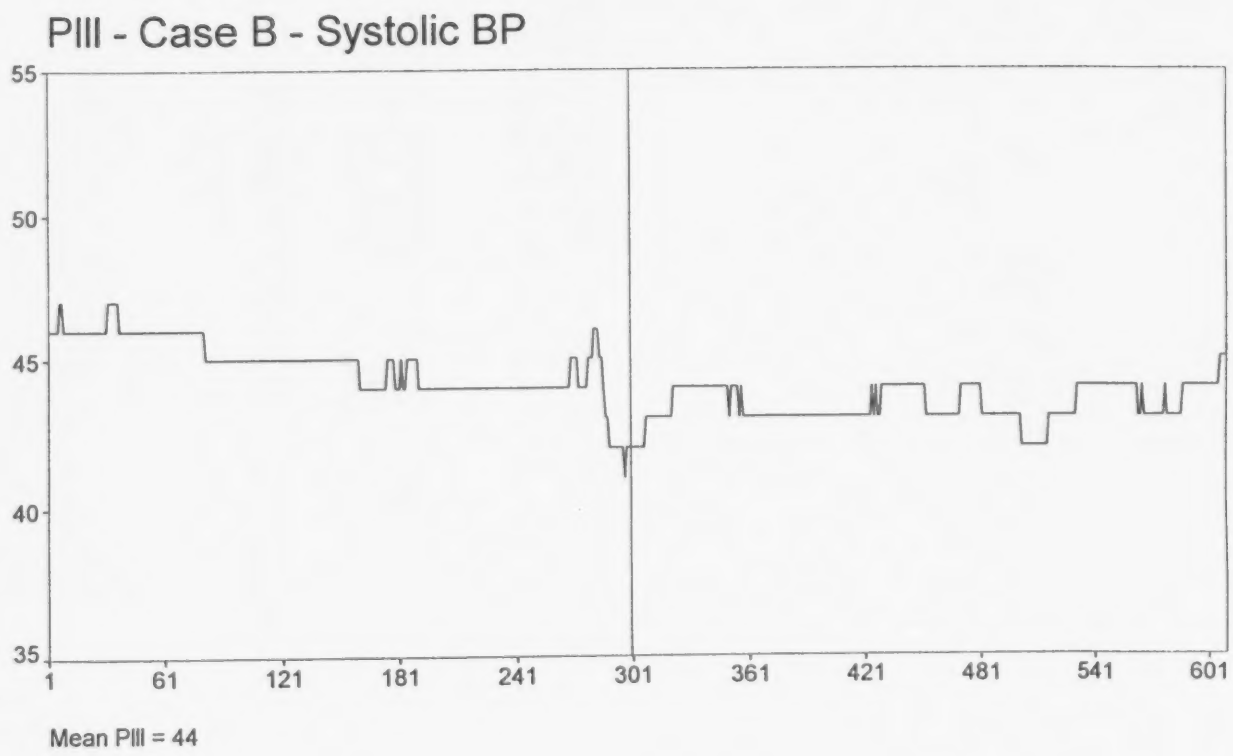

PHASE 11 - CASE C - Session 4
190
180
170
160
150
140
130
120
110
1
61
121
181
241
301
361
421
485
546
691
762
847
910
970
1,324
Time (60 sec intervals)
Mean P11 S4 HR = 151

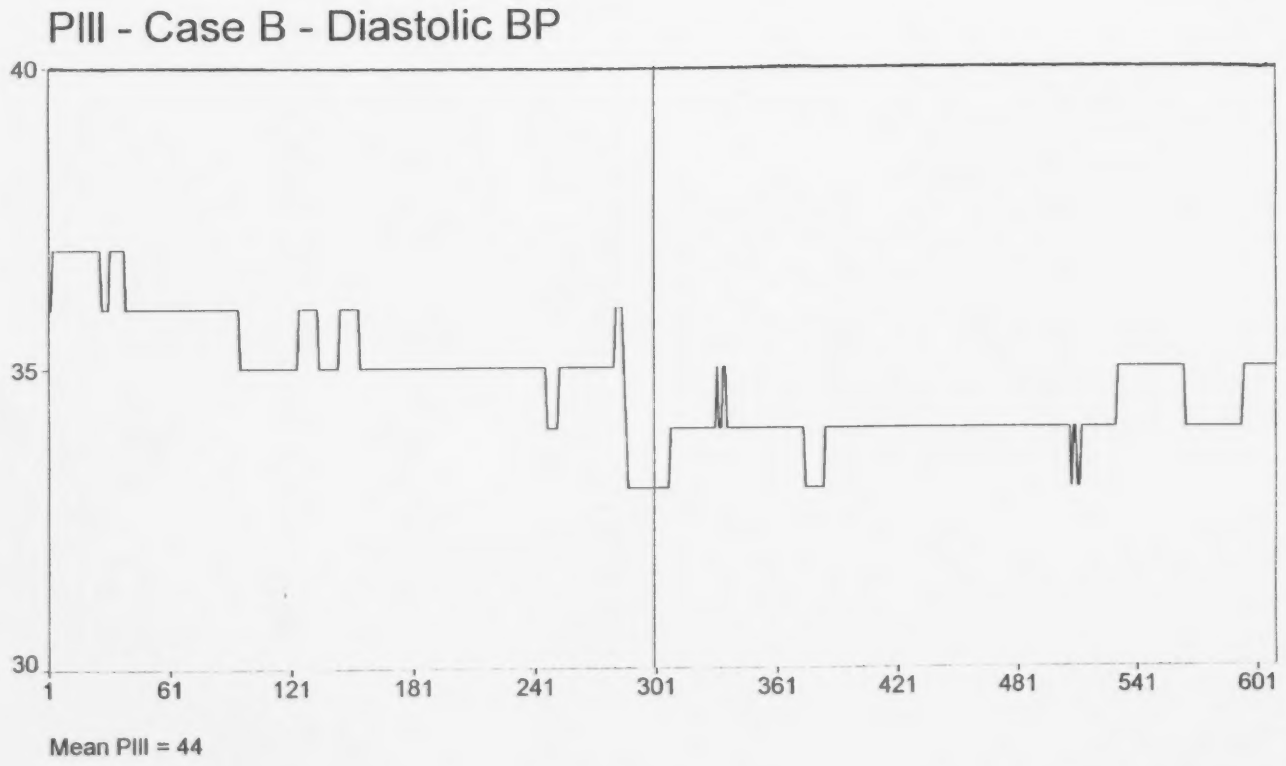
PHASE 111 - Case C - Session 1

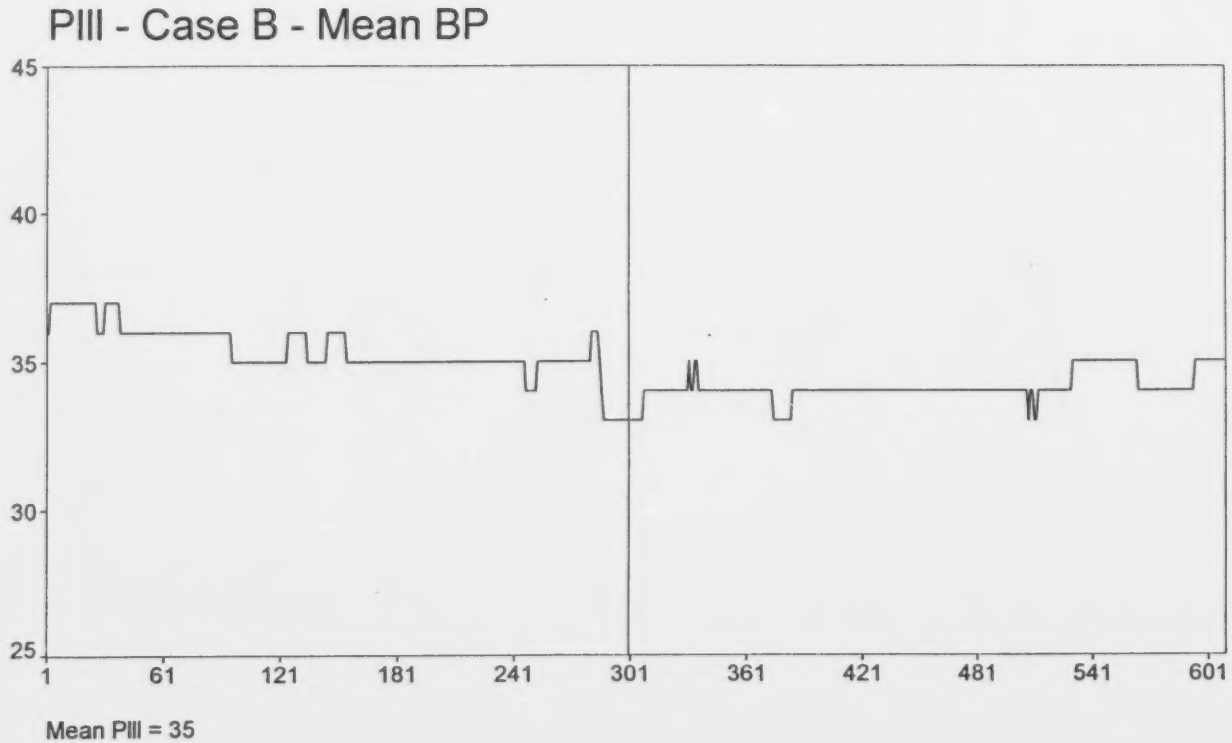


Time (60 sec intervals]

Mean P111 S1 HR=142


PIII - Case B - Systolic BP
55
50
45
40
35
1
61
121
181
241
301
361
421
481
541
601
Mean PIII = 44


PIII - Case B - Diastolic BP
40
35
30
1
61
121
181
241
301
361
421
481
541
601
Mean PIII = 44


PIII - Case B - Mean BP
45
40
35
30
25
1
61
121
181
241
301
361
421
481
541
601
Mean PIII = 35

Appendix B

University of Alberta
Edmonton
Canada T6G 2G3

Faculty of Nursing
3rd Floor Clinical Sciences Building

Certification of Ethical Acceptability for Research Involving Human Subjects

NAME OF APPLICANT(S): Rose Boyle, MN Candidate

TITLE OF PROJECT: "Learned Responses of Preterm Infants"

The members of the review committee, having examined the application for the above-named project, consider the procedures, as outlined by the applicant, to be acceptable on ethical grounds for research involving human subjects.

December 1, 1994
Date

M. Ruth Elliott
M. Ruth Elliott, PhD
Chair
Ethics Review Committee

PARENTS' CONSENT FORM:
INFANT LEARNED RESPONSE STUDY

REASON FOR DOING THE STUDY:

- premature babies seem to expect treatments even before they begin, possibly because they pick up signals from the surroundings
- the purpose of this study is to see if babies do learn to expect treatments and to record their responses
- this study is groundwork so that we can examine ways to improve the NICU surroundings and infant care

THE STANDARD CARE:

- babies in NICU may need to have mucous cleared from their airways
    - this is referred to as suctioning
- your baby ....
    - will need suctioning from time to time (as determined by the nurse or doctor caring for him or her)
    - may or may not be receiving some drugs as part of his or her care
    - will be having his or her heart rate, blood pressure and oxygen saturation measured.
        - these are referred to as physical measures

PROCEDURE:

Before your baby's first Suctioning we will ....

1. connect his or her wires to our monitor. It will send a copy of your baby's physical measures to a computer. This will not disturb the baby and the monitor is like those used in the NICU.

2. make a video recording of your baby so we can see how he or she reacted.

3. after 5 minutes, make a click-click sound which your baby will be able to hear. The sound will not startle the baby.

4. copy physical measures to the computer during this entire time.

During the first four suctionings, we will ...

1. make a video recording of your baby and record his or her physical measures 10 minutes before, during and 15 minutes after the suctioning

2. make the sound a few seconds before the suctioning. The suctioning will be done as usual, by the nurse caring for your baby.

An hour after the fourth suctioning, we will ....

1. make the sound again. This time the sound will not be followed by suctioning. Measures will be recorded to see what, if any, response he or she makes.

2. look at your baby's chart and make notes about his or her delivery and stay in the NICU

HOW SAFE WILL MY BABY BE?

1. there is no danger to the baby from being in this study. If your baby learns to expect the suctioning after the sound, he or she will soon forget. This will happen when there is no suctioning after the sound.

2. the click-click sound will not be made by any equipment or staff in the NICU, so the baby will not be confused.

3. your baby will not be touched or moved as part of this study or otherwise disturbed

WHAT WILL HAPPEN WITH THE INFORMATION?

1. it will be stored in a locked cupboard. We will not put your name or your baby's name on any study records or videotapes. We will use a coded number. We will not name you and your baby in any articles or talks about this study. We may use the videotapes later for educational purposes, to show the baby's responses.

2. you and your baby do not have to be part of this study. If you decide to join this study, you can drop out whenever you wish. Just tell the nurses or us.

WHO IS DOING THIS STUDY?

RESEARCHER:
Rose Boyle RN, BScN
MN Candidate
Faculty of Nursing
University of Alberta

SUPERVISOR:
Dr. J. Lander
Associate Dean
Research
Faculty of Nursing
University of Alberta

Phone:

492-9167 (office)
445-6763 (pager)

492-6763

SIGNATURES:

I have read this information and agree to allow my baby to join the Infant Learned Response Study.

_____ _____

(signature of parent) (date)